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Parameters of erythrocytopoiesis, acid resistance and population composition of erythrocytes of cows with chronic hematuria

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Clinically, chronic hematuria is a disease characterized mainly by symptoms of massive cystogamia, which can be constant or periodic and is accompanied by common phenomena of anemia. The object of the study was the blood of clinically healthy and chronic hematuria cows of the Brown Carpathian breed. Based on clinical studies, there are two stages of the disease in cows: subclinical and clinically pronounced. In turn, the clinically expressed stage of the disease is divided into medium and severe. The last stage was accompanied by massive hematuria. To study the pathogenesis of chronic hematuria of cattle, data of erythrocytopoiesis, acid resistance and population composition of erythrocytes in their blood are of great importance. Anemia in cows with an average degree of hematuria is characterized by oligocythemia and oligochroma and was mainly hyperchromatic macrocytic. Anemia due to severe course of the disease is hyperchromic and macrocytic, both indicators (MCH and MCV) are significantly higher than in cows for subclinical and moderate hematuria. Analysis of the population composition of blood erythrocytes indicates that the response of cellular populations is ambiguous. It was found that in cows with chronic hematuria, the relative number of "old" populations of erythrocytes that actively participate in oxygenation processes is decreased. The picture was similar with the population of "mature", most functionally active red blood cells. In particular, the number of "mature" cells in comparison with healthy cows was decreased by 7.0%. When studying the "young" forms of red blood cells, it was found that in the blood of cows suffering from chronic hematuria, they were growing, depending on the stage of the disease course. It is established, that the number of "young" populations of erythrocytes in the blood of cows in chronic hematuria was increased by 11.1% compared with clinically healthy animals. A significant decrease in the number of "old" and increasing "young" erythrocytes in the blood of cows suffering from chronic hematuria is a compensatory phenomenon in the development of hypoxia. Oxygen starvation due to anemia causes bone marrow irritation. Erythrogram in sick cows was characterized by a longer time of hemolysis of erythrocytes up to 6–7 minutes (in clinically healthy cows is completed by 5.5 min.). Erythrogram of cows in subclinical course of chronic hematuria peak of hemolysis accounted for 3 min (22.9%), whereas in cows with an average course of chronic hematuria, the acid hemolysis of erythrocytes was 3.5 minutes and its height was 15.5% of the hemolysed cells. Sick cows with a massive degree of course of chronic hematuria, the erythrogram had two peaks: for 3.5 min and 4.5 min, its height was respectively 12.9 and 11.7% of hemolyzed cells.

Key words: cattle; anemia; erythrogram; hemolysis; oxygen starvation

Introduction

Hematuria of cattle, as an independent disease, is widespread in many countries of the world. Registered in Europe, Asia, Australia, Africa, America and India. Of the European countries the most unfavorable for chronic hematuria are Germany, France, Bulgaria, Yugoslavia and Rumunia (Meshkov, 1957; Slivinska, 2005; You-Hsien et al., 2015).
In Ukraine, the disease is first mentioned in 1913 and is defined as a nosological unit (Meshkov, 1957). Chronic hematuria of cattle is found in the western regions of Ukraine, namely in the foothills and highlands of the Carpathians (Transcarpathian, Ivano-Frankivsk and Chernivtsi regions) (Gzhickij et al., 1957; Slivinska, 2007). The stationary foci of the disease are clearly limited to geographical areas: the presence of forests, mountainous terrain (Ogawa, 1993).
Chronic hematuria is a serious disease that is accompanied by the release of bloody urine (hematuria) and, as each chronic blood loss causes the development of posthemoragic anemia (Zaderij and Mishhenko, 1953, Dong et al., 2016). As a result of hypoxia and the accumulation of toxins, the detoxification function of the liver is impaired, and bone marrow hematopoiesis is suppressed (Araki et al., 2012; Yuste et al., 2015; Yuste et al., 2016). Thus, posthemoragic anemia is aggravated by hypoplastic anemia.
One of the important indicators of the functional state of the organs of hematopoiesis is the number of erythrocytes. The formation of erythrocytes (erythrocytopoiesis) is a genetically determined process that is provided by the proliferation and differentiation of erythroid progenitors in the hematopoietic organs of animals, is manifested in the early stages of prenatal development and during ontogenesis ensures the continuous supply of functionally mature cells to the circulation (Papauannopoulou, 1977; Barkagan et al., 1985; Han et al., 2014). Like other cellular components of mammalian blood, erythrocytes come from polypotent progenitors – hematopoietic stem cells, which give rise to all the branches of the hematopoietic process in the body. During the stay of erythroid cells in the bloodstream, the process of their differentiation ends. Thus the erythrocyte passes through the stages of a young, mature and old cell, each of which is characterized by specific features.
Therefore deserving of attention, from the point of view of the study of bone marrow functions, it is advisable to study age populations of erythrocytes: "young" – functionally immature, "mature" – functionally active and "old", which are involved in the processes of oxygenation. The study of the erythron system allows us to more objectively assess the state of the organism in anemia of various etiologies.
The aim of the work was to investigate the functional state of erythrocytes, in particular the population composition, the acid resistance of their membranes in healthy and sick chronic hematuria of cows.

Materials and methods

All animals were in the same conditions of maintenance and feeding. When carrying out the research, they adhered to the rules that are mandatory for performing zootechnical experiments on the selection and maintenance of animal analogues in groups, the technology of harvesting, use and accounting of consumed feed. The object of the study was the blood of clinically healthy and chronic hematuria of cows of the Brown Carpathian breed. The cows were examined clinically and laboratory blood tests were performed. General clinical analysis of blood included the calculation of erythrocytes (in the haemocytometer with grid), of hematocrit – by microcentrifuge (by Shkliar), content of hemoglobin – using the hemiglobincyanide method, ESR – according to T. P. Panchenko. Using the results, we calculated the average volume of erythrocytes (MCV) and the content of hemoglobin in a single erythrocyte (MCH) (Levchenko et al., 2010). Acid resistance of erythrocytes with the following construction of erythrograms was studied by (Popauannopoulou, 1977), the population composition of erythrocytes in a gradient of sucrose density by (Sizova et al., 1980).
The mathematical processing of the results of the studies was processed statistically with the help of Statistica 6.0. The results of the average values were considered statistically significant at * – $P < 0.05$ (ANOVA).

Results

Based on clinical studies, we identified two stages of the disease: subclinical course (latent stage) and clinically pronounced. The latter, depending on the symptoms developing and results, the study of blood and urine, is divided into two stages – medium and heavy, which was accompanied by massive hematuria (Casadevall and Vainchenker, 1993).
At an average degree of hematuria, the animals were of average fatness, only 5 of 37 cows (13.5%) are below average, the body temperature is within the normal range. In 83.8% – conjunctiva, sclera, mucous membranes of the nose and mouth are anemic, others – pale pink. A cardiac impulse in a third of the cows of moderate strength, in the others were diagnosed its intensification. Heart tones are clear in 10.8%, in 5.4% – strengthened, in the remaining sick cows – weakened.
Severe anemia was accompanied by massive hematuria. In 92.4% of animals, visible mucous membranes, in particular conjunctiva, sclera, mucous membranes of nose and mouth - pale with porcelain and even cyanotic shade, body temperature was decreased by 0.5–1.0 ° C. The pulse and respiration rate was increased in 51.7% of cows, the pulse was often arrhythmic, of weak filling.
Heart thrust at massive hematuria is intensified in 82.8% of animals, in others – weakened. At auscultation, the first tone intensification was detected in 13 cows (44.8%), amplification of both tones – in 6 out of 29 studied 20.7%. In 10 cows (20.7%) a quiet, gentle, blowing systolic noise was found in p. opt. pulmonary artery. Cardiac noise is obviously caused by anemia, which is accompanied by an increase in the rate of passage of blood through the initial part of the pulmonary artery.

The number of erythrocytes in subclinical course of chronic hematuria ranged from 3.6 to 5.9 × 10^{12}/l and averaged 4.3 ± 0.10 × 10^{12}/l.

Oligocythemia was established in 23 cows (95.8%), what is more in 4 (16.7%) erythrocytes was less than 4.0 × 10^{12}/l, in 16 – from 4.0 to 4.5 × 10^{12}/l (66.7%). In 20 cows (83.3%), oligocythemia was combined with oligochromia (Table 1). Anisocytosis was observed in two cows.

Oligochromia was established in 20 cows (83.3%), but only in 2 hemoglobin was less than 80 g/l, in 18 (75.0%) – from 80 to 95 g/l.

Important for determining the causes of anemia is the determination of the saturation of each erythrocyte with hemoglobin. In subclinical course of chronic hematuria, the limits of this indicator were in the range from 19.1 to 21.9 pg. In healthy cattle, the maximum value is 20 pg. The insignificant hyperchromia (20.5–21.9 pg) was established by us in 10 cows (41.9%).

To establish the nature of anemia in clinical practice, red blood indices are analyzed. One of them is the color index, which in subclinical course of chronic hematuria was fluctuated from 0.99 to 1.15, which corresponds to physiological boundaries. Therefore, the determination of erythrocyte saturation with hemoglobin is a more informative test in comparison with the color index for diagnosing the subclinical course of chronic hematuria.

At subclinical hematuria, the erythrocyte sedimentation rate was averaged 0.6 ± 0.05 mm. However, in 6 cows (25%) the indicator was above 0.8, which, in our opinion, is not enough informative test of the early diagnosis of anemia.

The hematocrit size depends on the number of erythrocytes and their average volume. At subclinical flow, the hematocrit value of 24 cows was less than the minimum norm and ranged from 24.0 to 31.0%, which is explained by oligocythemia, because none of the cows have microcytosis. On the contrary, in 20 cows out of the 24 investigated (83.3%) red blood cells were somewhat larger than 60 μm^3, including 33.3% – 65 μm^3. The combination of hyperchromia with macrocytosis was established in 8 cows (34.8%). Given these changes (oligocythemia, hyperchromia and macrocytosis), it can be assumed, that one of the causes of anemia is a lack of cobalt.

Table 1. Blood indices for different course of chronic haematuria of cows (Mean ± dispersion)

Index	Subclinical course of hematuria (n = 24)	Average degree of hematuria (n = 37)	Massive hematuria (n = 29)
Erythrocytes, 10^{12}/l	4.30±0.10	3.70±0.06 *	1.70±0.08 *
Hemoglobin, g/l	88.50±2.06	77.90±1.43	42.20±2.28 *
Saturation of erythrocyte with hemoglobin, pg	20.50±0.18	21.10±0.45	24.80±0.73 *
Color metric	1.10±0.01	1.10±0.02	1.30±0.01 *
Rate of erythrocyte sedimentation, mm	0.60±0.05	1.50±0.05	3.0±0.18 *
The hematocrit value, percentages	27.70±0.37	25.30±0.24	20.60±0.34 *
Mean erythrocyte volume um^3	64.40±0.80	68.40±1.02	121.20±3.97 *

Note: * – P ≤ 0.05 – in comparison with the subclinical course

At an average grade of hematuria, 37 cows were examined. Erythrocytes in them was authentically (P < 0.001) less than for subclinical course. In 100% of cows, erythrocytes was less than 5.0 × 10^{12}/l, including 72.9% less than 4.0 × 10^{12}/l.

The content of hemoglobin in the average degree of chronic hematuria was in the range from 65 to 98 g/l and in 34 cows out of 37 (91.9%) oligochroma have been installed, and in 21 (56.8%) hemoglobin was less than 80 g/l, including 4 (10.8%) less than 70 g/l (Slivinska, 2005).

So, anemia in cows with an average degree of hematuria is characterized by oligocythemia and oligochromia, and in 91.9% of cows these changes are combined with erythrocytopoiesis.

The saturation of erythrocytes with hemoglobin ranged from 18.1 to 31.6 pg and in 29 cows out of 37 (78.4%) hyperchromia was established, the rest – normochromia. The color index in cows with an average degree of haematuria in 5 cows (13.5%) was large 1.15 and was associated with an increase in the saturation of erythrocytes with hemoglobin. As can be seen from the results, the saturation of erythrocytes with hemoglobin is more informative. Its increase is significant (P < 0.001) expressed in cows with an average degree of hematuria, compared with the subclinical course of the disease. The determination of red blood indices – the color index and the average hemoglobin content in one erythrocyte – allows to reveal not only the nature of anemia, but sometimes its cause.

According to the average degree of chronic hematuria, the color index ranged from 1.0 to 2.0. In one of the sick cows, the index did not reach the upper physiological limit. Although the color index is not specific for any disease, however, its change is always an indicator of the presence of a pathological process in the body.

The hematocrit in all cows did not reach even 30%, averaged 25.3 ± 0.24% and was significantly (P < 0.001) less than the subclinical course of hematuria. Reduction of the hematocrit value, as in the subclinical course of the disease, was due to oligocythemia, as the average volume of erythrocytes in 36 of 37 cows (97.3%) was large 60 μm^3, including 30 (81.8%) – 65 μm^3. The volume of erythrocytes ranged from 56.3 to 90 μm^3. In sick cows with an average grade of hematuria, we have established a direct correlation between the hemoglobin content in the erythrocyte and their mean volume (r = +0.74).

So, anemia with an average degree of chronic hematuria was mainly hyperchromic macrocytic.

The number of erythrocytes of massive course of hematuria was very low and fluctuated within 1.2–2.9 × 10^{12}/l, that is 2.5 times less than the number of erythrocytes in subclinical hematuria and in 2.2 times - with an average degree. In 16 cows (58.6%), the number of erythrocytes was below 1.7 × 10^{12}/l. In 28 patients with cows (96.6%), oligocythemia was combined with oligochroma. Aniso- and poikilocytosis was diagnosed in 23 (79.3%) sick cows, and in 6 animals (20.7%), anisocytosis was noted (Slivinska, 2005). With a chronic course of massive hematuria, the hemoglobin content ranged from 31.0–93.0 g/l. In 28 cows from 29 the hemoglobin content was below 59.0 g/l, only in one cow this indicator reached 93.0 g/l.

The saturation of erythrocytes with hemoglobin in cows with massive hematuria varies from 21.1 to 32.3 pg. In 29 (100%) patients with chronic hematuria of cows, the index was higher than the upper limit of physiological fluctuations (hyperchromic anemia). The color index for massive hematuria in 21 of 29 cows was greater than the upper limit of normal (1.15), which is also a confirmation of the development of this type of anemia in sick cows.

The hematocrit value in cows for massive hematuria was 4.7 and 7.1% (P < 0.001) lower than with an average degree of hematuria and subclinical hematuria. In 6 cows (20.7%) the hematocrit value was less than 20.0%. The decrease in the hematocrit value was due to oligocythemia, since the average volume of erythrocytes in 100% of cows was large 65 μm^3, including 26 of 29–100 μm^3.

The average volume of erythrocytes in the blood of cows for massive hematuria was large in 1.9 and 1.75 times (P < 0.001) in comparison with the subclinical course of hematuria and the average degree of hematuria. Thus, anemia due to severe course of the disease is hyperchromic and macrocytic, both indicators (hemoglobin saturation and mean erythrocyte volume) are significantly higher than in cows for subclinical and medium hematuria.

The sedimentation rate of erythrocytes for massive hematuria in all sick animals was significantly higher in comparison with the subclinical course of hematuria and the average degree of hematuria (P < 0.001).

Anemia in cows is not only a result of chronic hematuria. It is believed that a number of factors operate here. It is impossible to exclude the negative effect of deficiency in the rations of the cows of elements that stimulate hemopoiesis, in particular cobalt and copper.

Fractionation of erythrocytes in a sucrose density gradient in subclinical course of chronic hematuria has shown, that the number of populations of "old" and "mature" cells was characterized by a tendency to decrease, but did not differ significantly from clinically healthy cows (Table 2). The number of "young" populations of erythrocytes in the blood of cows for subclinical course of chronic hematuria was within 46.1–54.8%, which was 2.1% more than clinically healthy (P < 0.05).

With an average degree of chronic hematuria, the population of "old" cells continues to decrease, and their number is significantly less (P < 0.01) in comparison with clinically healthy cows (Table 2).

Table 2. Parameters of the population composition of erythrocytes in cows with chronic hematuria (in percent), M ± m, n = 20

Group of animals		"The old"	"Mature"	"Young"
Healthy Cows		12.20±0.32	40.70±0.55	47.10±0.51
Sick Cows	Subclinical course of hematuria	11.90±0.19	38.90±0.79	49.20±0.84*
	Average degree of hematuria	10.30±0.51*	33.70±0.87 *	56.0±0.64 *
	Massive hematuria	9.40±0.39 *	32.40±0.60 *	58.20±0.83 *

Note: * – P ≤ 0.05 – in comparison with clinically healthy cows

Differences were found in the population composition of "mature" and "young" cells with an average degree of hematuria. In particular, the number of "mature" cells in comparison with healthy cows was reduced by 7.0% (P < 0.001). Also, a significant decrease in their percentage by 5.2% (P < 0.001) was found in comparison with cows with subclinical disease course. At the same time, the number of "young" forms of erythrocytes in the cows was increased in comparison with clinically healthy animals (P < 0.001) and subclinical course of hematuria (P < 0.001).

With a massive degree of chronic hematuria course (Table 1), the number of "old" populations continued to decrease by 22.9% (P < 0.001). A prolonged state of hypoxia contributes to their rapid "aging", which leads to more intensive processes of erythrocyte oxygenation. A similar trend was observed in the analysis of "mature" erythrocytes: they were 8.3% less for massive hematuria than for clinically healthy hematuria. The number of "young" populations of erythrocytes in the blood of cows with massive hematuria was increased, which was 11.1% more than in clinically healthy animals (P < 0.001), 9.0% for subclinical hematuria, and 3.8% for moderate hematuria.

The duration of hemolysis of erythrocytes depends on the time needed to overcome the hemolytic membrane barrier, the rate of destruction of intracellular structures and the time during which the mechanical strength of the membranes resists the increasing osmotic pressure within the cell.

Thus, the stability of erythrocytes depends on their age, composition and can change in pathological processes of the body, in particular anemia.

The development of anemia in cows suffering from chronic hematuria leads to the appearance of a hypoxic state of the body. Oxygen starvation due to anemia causes bone marrow irritation. At the same time, a large number of "young", possibly even immature, erythrocytes enter the bloodstream, which is aimed at eliminating oxygen deficiency and excess carbon dioxide in the body. So, a significant decrease in the number of "old" and increasing "young" erythrocytes in the blood of cows suffering from chronic hematuria is a compensatory phenomenon in the development of hypoxia. The pathological condition in patients with chronic hematuria of cows is aggravated with each subsequent stage of the disease, which leads to the exhaustion of the compensatory forces of the organism.

Analysis of the graphic representation of the acid resistance of erythrocytes in clinically healthy cows of the Brown Carpathian breed was characterized by a peak of hemolysis at 3.0 minutes, and its height was 24.9%. Hemolysis took place dynamically and completely ended at 5.5 minutes (Fig. 1).

Erythrogram of cows in subclinical course of chronic hematuria has a peak of hemolysis at 3 minutes (22.9%). The peak height was lower by 2.0% from clinically healthy animals (Fig. 1). Hemolysis of erythrocytes is completed in the 6th minute. The left part of the graphs, which is characterized by hemolysis of the "old" and "mature" populations, are almost identical in healthy cows and in subclinical course.

In cows with an average course of chronic hematuria, the acid hemolysis of erythrocytes was significantly different from the previous ones. The left side of the graph was longer, the time of the main peak was 3.5 minutes, and its height was 15.5% of the hemolyzed cells, which indicates an intensified hemolysis of the "mature" erythrocytes. Because the hemolysis of the "young", functionally immature and hemolytic-resistant red blood cells occurred more slowly, the right side of the chart was more shallow, and complete hemolysis occurred for 6.5 minutes, which was 1 minute longer than clinically healthy animals (Fig. 1).

In sick cows with a massive degree of chronic hematuria course, the erythrogram had two peaks: the primary and the secondary (Fig. 1). The time of release of the main peak was maximal at 3.5 minutes and was 12.9% of hemolyzed cells. The time of release of the main peak was maximal at 3.5 minutes and was 12.9% of hemolyzed cells.

Analysis of the graphic representation of the acid resistance of erythrocytes showed enhanced hemolysis of the "old" erythrocytes as evidenced by the left side of the graph.

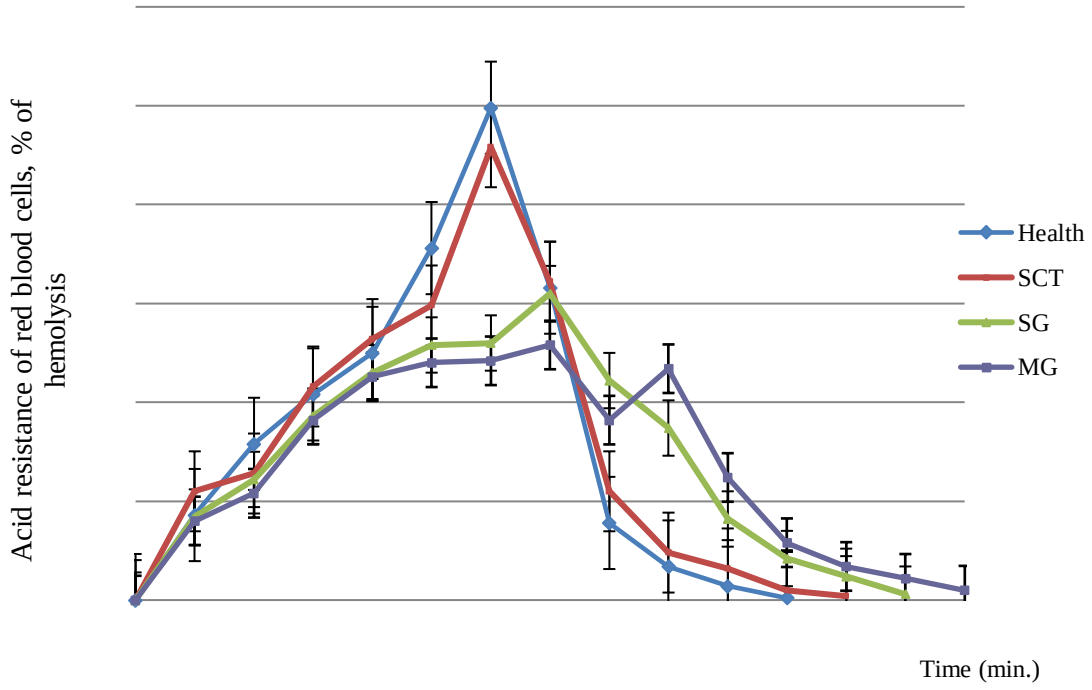

Figure 1. Acidic resistance of erythrocytes of healthy and patients with chronic hematuria of cows (SCT is the subclinical course of hematuria, SG – the average degree of hematuria; MG – massive hematuria)

The second peak of the erythrogram was 4.5 minutes and was 11.7% of the hemolyzed cells. Hemolysis of erythrocytes was longer and completed at 7 minutes, which was 1.5 minutes longer than in clinically healthy animals, and 1.0 min when compared with subclinical hematuria.

Dual split of the erythrogram peak in cows with a massive course of chronic hematuria indicates the presence of red blood cells in the blood stream with different membrane properties. Delayed destruction and shift of the graph to the right is an indicator of the presence in the bloodstream of more resistant to hemolysis "young" populations of red blood cells.

Discussion

In clinical terms, this disease is characterized mainly by symptoms of massive cystogamous hematuria, which can be constant or periodic and is accompanied by common anemia phenomena (Zaderij and Mishhenko, 1953, Dong et al., 2016). Deficiency of Co and Cu and lead excess deepen the anemic syndrome caused by chronic hematuria (Araki et al., 2012). It was found that the most pronounced changes in cows with chronic hematuria were found in the organs of urination (Maeda, 1978; Barkagan et al., 1985). Erections, papillomatous growths were found in the bladder of sick cows, and urothelial carcinoma in 37.5%. The reason for such changes is the eating of herbs that contain toxic substances, in particular ptacvilozide and anemonol. The kidneys showed signs characteristic of focal interstitial nephritis (Abrantes et al., 2006; Slivinska, 2007).

It is also important in the emergence and spread of chronic hematuria several factors: intoxication with excess content in soil and feed of lead, iodine, fluorine, iron, aluminum; insufficiency of calcium; intoxication with microorganisms from the group of anaerobes falling with forages from the soil; the effect of ionizing radiation as a result of the assimilation of radioactive isotopes from plant feed and water in permanently disadvantaged areas. The disease is often the result of an action parallel to several etiological factors (Perez-Alenza et al., 2006; Joseph and Gattineni, 2016).

The spread of anemia was studied according to the results of a clinical study of cows and a laboratory (general clinical) blood test. Chronic hematuria was diagnosed in 336 cows, 3.2% of the Transcarpathian cows and 1% of the Chernivtsi region. Among the cows, 20.5% are dry stable, 267 – milch (79.5%), including 139 (41.4%) – with young calf and 128 (38.1%) – are inactive. Cows of five (25.6%) six (21.7%), four – (18.2%) and three (12.2%) age were more often ill, less often – 7–10 years. Each of these areas has districts and settlements where the disease was diagnosed more often (Slivinska, 2007). Each of these areas has districts and settlements where the disease was diagnosed more often (Slivinska, 2007). As a rule, these are foothill and mountainous areas of Velykobereznyansky, Svalyava and Khust districts of Transcarpathian; Rozhnyatyn and Nadvirnyansky districts of Ivano-Frankivsk, Vyzhnytsya and Putylj districts of Chernivtsi region. The disease was more often registered in the stall period among dairy cows (79.5%).

The stationary foci of chronic hematuria are confined to clearly defined geographic zones, most often this disease is registered in the foothills and mountainous Carpathians, in some permanently, and in others – rarely (Slivinska, 2005).

An analysis of the obtained results gives us reason to say, that under the conditions of the western biogeochemical zone, one can not in any case speak for a separate type of anemia. Even cases of chronic hematuria are registered in territories whose soils are depleted of essential trace elements, which means posthemorrhagic anemia, as a leading one, is supplemented by the negative influence of alimentary-deficient factors (low level of cobalt, copper, vitamins B12 and Vc in the blood). In the same way, one can characterize anemia in the zone of technogenic pollution by cadmium and lead, because here the feed is depleted in cobalt and copper, and in the blood serum the low content of both trace elements.

To study the pathogenesis and diagnosis of chronic hematuria of cattle, data on erythrocytopoiesis, acid resistance and population composition of erythrocytes are of great importance. Changes in the number of erythrocytes and hemoglobin content depended on the form of the course of chronic hematuria. By subclinical form (n = 24) oligochroma and oligocythemia were established in 20 cows (83.3%), oligocythemia – in 3 (12.5%). So, anemic syndrome was diagnosed in 23 cows (95.8%). Anemia with this form of normal (56.5% of cows) or hyperchromic (43.5%), mostly (65.2%) normocytic, less often (34.8%) – macrocytic.

According to the average degree of hematuria (n = 37), anemic syndrome is diagnosed in 100% of cows, and the combination of oligochroma with oligocythemia is established in 91.9% of cows, in others, oligocythemia was determined. The number of cows with hyperchromic erythrocytes is increased to 78.4%, anemia in 81.8% of cows is macrocytic. Between the mean volume of erythrocytes and their hemoglobin saturation, a direct correlation was established (r = + 0.74). In massive hematuria (n = 29), the combination of oligochroma with oligocythemia was established in 28 cows (96.6%), only oligocythemia in one (3.4%). Anemia in all cows is hyperchromic, macrocytic, and in 89.6% of cows the average volume of erythrocytes exceeded 100 μk^3.

So, if anemia is characterized in descending order in the unit of blood volume, only hemoglobin or its combination with oligocythemia, then we can state the development of the syndrome in 82 cows out of 90 (91.1%), and taking into account cows that have an additional oligocythemia, 89 (98.8%).

In cows with chronic hematuria erythrogram is characterized by a decrease in the number of "old" and "mature" and an increase in "young" populations of erythrocytes.

Acid resistance of erythrocyte membranes in sick cows was characterized by a longer time of hemolysis and a shift of the erythrogram peak to the right.

In chronic hematuria (Slivinska, 2013) posthemorrhagic anemia is combined with alimentary-deficient anemia: in the blood the content of cobalt is decreasing (0.22 ± 0.012 – 0.29 ± 0.08 μmol/l), copper (11.5 ± 3.0 – 12.8 ± 0.51 μmol/l), cyanocobalamin (204.4 ± 2.84 pg/ml in massive hematuria, 300.0 ± 18.17 - in the subclinical stage) and folic acid (12.0 ± 0.30 and 13.3 ± 0.23 ng/ml clinically healthy cows, respectively, 0.55 ± 0.017 and 15.6 ± 0.28 μmol/l 582.8 ± 25.40 pg/ml and 14.9 ± 0.35 ng/ml).

Conclusion

The main zones of spread of chronic hematuria of cattle are the foothills and mountain territories of Velykobereznyany, Svalyava and Khust districts of Transcarpathian; Rozhnyatyn, and Nadvirnyansk districts of Ivano-Frankivsk; Vizhnytsya and Putylj districts of the Chernivtsi region. From studied 363 heads of cattle, with chronic hematuria, the cows were 92.6% of the total, the heifers were 5.8, the young at the age of 4–6 months. – 1.6%. Among the cows – 69 (20.5%) are dry stable, the remaining 267 – milking (79.5%). Cows predominate at the age of five (25.6%), six (21.7%), four (18.2%) and three (12.2%), less often (22.3%) cows of 7–10 years of age. The disease is more often regestered in the stall period.

According to the subclinical course of chronic hematuria, the enemy syndrome is established in 95.8% of cows, clinically expressed – 100%. Anemia in the subclinical course of normo- (56.5% of cows) or hyperchromic (43.5%), mostly (65.2%) is normocytic, less often (34.8%) is macrocytic, by massive hematuria – in 100% of cows hyperchromic (24.8 ± 0.73 pg) and macrocytic (121.2 ± 3.97 mkm^3). Population composition of erythrocytes is characterized by a decrease in the proportion of "mature" and "old" erythrocytes and an increase in "young", and erythrogram – extended hemolysis of erythrocytes up to 6–7 minutes (for clinically healthy cows, it ends by 5.5 minutes).

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