

About the relationship between blood indicators in cows and their reproductive function

Murat Hamidulloevich Baimishev

Samara State Agricultural Academy, 446442, Russia, Samara Region, Ust-Kinelsky, Uchebnaya St., 2

Sergey Petrovich Eremin

Nizhny Novgorod State Agricultural Academy, 603107 Russia, Nizhny Novgorod, Gagarin Ave., 97

Khamidulla Baltukhanovich Baimishev

Samara State Agricultural Academy, 446442, Russia, Samara Region, Ust-Kinelsky, Uchebnaya St., 2

Viktor Viktorovich Zemlyankin

Samara State Agricultural Academy, 446442, Russia, Samara Region, Ust-Kinelsky, Uchebnaya St., 2

Khaidar Akhmetabirovich Safullin

Samara State Agricultural Academy, 446442, Russia, Samara Region, Ust-Kinelsky, Uchebnaya St., 2

Abstract

The research was aimed at determining the relationship between blood parameters in cows before calving and during delivery, and manifestations of postdelivery pathologies. A group of 40 cows was formed for this purpose. The groups of animals were formed with regard to their physiological state during the second half of pregnancy, 2-3 months before calving. For this purpose, zootechnical accounting data were used, as well as the results of rectal and ultrasound examination for pregnancy with the use of a KAIXIN-2000 Vet device. Blood was taken for study 25 to 30 days before calving. Blood parameters were studied using conventional methods with the use of certified equipment. Then hematological parameters of cows were comparatively assessed, depending on the peculiarities of the delivery process. The most important indicators predicting manifestations of postdelivery complications are decreased hemoglobin content, total protein, globulins, alkaline reserve and the increased content of beta-globulins, as well as reliable excess of the threshold by the ALT and AST enzymes.

Keywords: blood, delivery, involution, pathology, heam.

INTRODUCTION

It is known that the morphological composition of blood is one of the main information systems that attracts attention of researchers for determining the norms of physiological state of animals, or the presence of pathological processes in the organism.

An important step in determining the aetiology of disruption of the reproductive function in cows is determining the indicators of morphobiochemical composition of blood. However, they do not always give accurate information about the state of metabolic processes in the organism due to the presence of a complex integrative system of regulating exchange processes and reproductive functions. However, opinions of the researchers about this problem differ. A number of researchers recommend considering blood indicators along with the level of productivity during the development of therapeutic measures and measures to enhance the reproductive ability of high yielding cows [1].

To date, the basis for taking measures aimed at preventing and treating postdelivery diseases is the use of medications that are not always effective due to various side effects on other systems, organs and the organism of the animal as a whole. Moreover, these measures are taken without monitoring the morphofunctional state of the animal organism [2].

In the global and domestic veterinary practice, there are no criteria for predicting the nature of the delivery process and the postdelivery period in terms of blood indicators long before calving. Development of hematologic criteria for predicting the delivery process and the postdelivery period in cows will allow timely correction for preventing postdelivery complications in cows [3].

The performed research will allow improving the methods of monitoring metabolism in cows during pregnancy, and will also be used to develop optimal technologies of keeping and feeding pregnant cows through examining blood criteria in certain periods of pregnancy. In this respect, determination of the relationship of the optimal blood gradient in cows before delivery

that the morphological with the manifestation of delivery and postdelivery complications is an urgent problem.

The research was aimed at determining the relationship between blood parameters in cows before calving and the delivery process, and postnatal pathologies. The following tasks were set for this purpose:

- studying the morphobiochemical, immune-biological parameters of blood in cows 25 to 30 days before calving;
- determining the nature of the delivery process and the postdelivery period in cows; and
- comparative analysis of blood parameters in cows depending on the course of delivery and the postdelivery period.

METHODS

The material for the study was the blood obtained from the Holstein cows that were kept in the conditions of the dairy complex of the Integrated Agricultural Production Centre "Olginsky OP Novokurovskoe" LLC. For this purpose, a group of animals after the first lactation with milk production on average of 8,216 kg, and the live weight of 617 kg was formed using the method of analogous pairs. The groups of animals were formed with regard to their physiological state during the second half of pregnancy, 2-3 months before calving. For this purpose, zootechnical accounting data were used by the results of ultrasound examination for pregnancy with the use of a KAIXIN-5200 VET device.

During the study, all animals were in the same feeding and housing (united box housing) conditions. The study group of 40 animals was formed. In order to determine the morphological and physiological state of the cows, blood was taken from all animals 25 to 30 days before calving. Blood was taken from tail vein using the closed Monojet system at the same time of day, two hours after feeding, into two containers: one for obtaining serum,

and the other with addition of heparin for making analysis with the whole blood.

Morphological, biochemical and immunological parameters of blood were determined according to the standard methods. The number of erythrocytes and hemoglobin concentration were determined using a photoelectric hemoscope; leukocytes were counted using the standardized method in a Goryaev chamber; the content of total protein in serum was determined with a LPR-3 refractometer; separation and quantitative determination of serum proteins' fractions ratio were performed by the nephelometric method; the content of carotene was determined by the method for determining carotene in blood serum according to Carr-Price in the modification of Yudkin; concentration of total protein and calcium in blood serum was determined comprehensively metrically; the level of inorganic phosphorus was determined by the method of Brix in the modification of A.S. Ivanovsky; the amount of immunoglobulins A, M, G was determined using a Hitachi laboratory (Japan); the alkaline reserve was determined by the method Rayevski; and sugar was determined by the orthotoluidine method for determining sugar in blood serum.

Reproductive indicators of the examined group of cows were studied by the following parameters: the course of delivery and the postdelivery period, manifestation of postdelivery complications. By the results of the course of delivery and the postdelivery period, the studied group of cows was divided into two groups: the first group included the animals in which delivery and the postdelivery period passed without pathologies; and the second group included the animals in which there was disruption of delivery and the postdelivery period. Next, blood indicators of the studied groups of cows were analyzed, depending on the nature of the delivery process and the postdelivery period to determine which blood parameters and gradients of their parameters ensured normal delivery and postdelivery period in cows. The use of these methods allowed solving the set tasks. No permit was required for the studies, since the work was completed at the farm within the framework of the research work under topic "Ecological, morphological adaptation and improving methods of diagnostics, treatment, and prevention of diseases of animals in the conditions of intensive technology", state registration No. 01.200712415.

The digital material of the experimental data was processed by the method of variation statistics for veracious difference of compared parameters with the use of the Student's test adopted in veterinary medicine and biology and the Microsoft Excel 7 application suite. Reliability of the processed data is reflected by corresponding designations: $P < 0.05^*$; $P < 0.01^{**}$; $P < 0.001^{***}$.

LITERATURE REVIEW

Blood is the most available tissue for research, as it largely characterizes the morphological and functional state of animal organism. If the effect of exogenous and endogenous factors of the organism is disrupted, the labile system such as blood is the first to react [2, 4].

It is known that the amount of hemoglobin in the blood of animals changes according to the changes in the quantity of red blood cells. Thus, its content in the blood of pregnant cows, according to N. Adili, M. Melizi [5], increases by 5.3%. According to the data of Mazzullo Giuseppe, Rifici Claudia, Caccano Gino, Giuseppe Piccione [4], the hemoglobin content in the blood of cows decreases by 5-13% to the end of pregnancy.

A number of researchers like T. Aoki, H. Honda, M. Ishii [2]; J.E.P. Santos, E.S. Ribeiro [6], when assessing changes in the number of leukocytes during pregnancy in cows, note their increased number by 15-20%.

According to A. Idrees, Z. I. Chaudhary & M. Younus

[7], increasing the number of leukocytes before delivery in cows results in changing the indicators of leukogram during the first hours after delivery that are characterized by neutrophilic leukocytosis.

Biochemical indexes of blood are the most important in assessing the influence of pregnancy on the animals organisms. The nature of changes in the blood alkali reserve in cattle influenced by pregnancy was studied by B. M. Oyawoye, H. N. Ogunkunle [8], T. E. Grigoriev [9], who noted the reduced alkalinity reserve in cows on the 2-3th month of pregnancy, and noted its increase by 14%.

J.J. Kaneko, J.W. Harvey, M.L. Bruss [10] noted that acid capacity in postdelivery cows had been increased by 16%, and 10 days later did not exceed the baseline values.

According to Nse Abasi N. Etim, E. Glory Enyenihi, E. Mary Williams, D. Meti Abasi, Udoand E.A. Offiong Edem [11], after delivery, the amount of gamma-globulins increases in the blood serum of cows by 10-18%, the amount of alpha-globulins – by 5-8%, while the overall amount of albumins decreases.

The mineral composition of animal blood during pregnancy changes most significantly in terms of calcium content, depending on the duration of pregnancy. Thus, B. M. Oyawoye, H. N. Ogunkunle [8] found increased calcium content in the blood of cows by 6.8% in the second half of pregnancy.

Numerous researchers believe that the etiological basis of postdelivery complications is the reduced metabolism in pregnant cows with longer lactation, which results in impaired contractility of the uterus, accompanied by weakening of the degenerative – regenerative processes with involution of the genital organs [12; 13].

According to other authors, the main reason of postdelivery pathology should be considered the violation of the animal feeding technology during pregnancy. The authors note that excess of calcium, magnesium, fiber in the diet combined with shortage of sugar, phosphorus, copper, and carotene influence the manifestation of postdelivery complications [14].

In analyzing delivery, D. Wood, G. F. Quiroz-Rocha [15], S.A. Yolov, A.S. Atanasov, G.B. Georgiev, J.D. Dineva, N.A. Palova [16] found that one month after delivery, there was an increase in the number of red blood cells, glucose, total lipids, enzymatic activity of AST and ALT, and a decrease in the content of leukocytes, total bilirubin, β -globulins and γ -globulins.

Focused study of the influence of the factors of organism's nonspecific protection on pregnancy and delivery is important for disclosing internal mechanisms and methods of correcting natural resistance of the organism; they point to the possibility of developing prevention methods using parameters of cellular and humoral protection of animal organisms [2, 17].

A. G. Nezhdanov, K. A. Lobodin [14], A. Yolov, A.S. Atanasov, G.B. Georgiev, J.D. Dineva, N.A. Palova [16], N. Adili, M. Melizi [5], S. V. Shabunin, et al. [12] have found that in the modern economy the problem of infertility prevention is still very urgent in the veterinary science. Scientific researches of the recent years suggest that pathology of pregnancy, delivery and the postdelivery period in animals is based on functional metabolic disorders. As a result of hematologic and hormonal studies, the authors have found that in animals predisposed to delivery and delivery abnormalities, the content of vitamins B and C in the blood decreases, and the levels of progesterone, calcium, cholesterol increase, which, according to the authors, affects resistance of the animal organisms.

However, the basic blood counts have not been determined so far, which could be used for developing the method of predicting and correcting the postdelivery state of high yielding cows.

RESULTS

The studies of the hematological, biochemical, immunological blood parameters in cows within 25 to 30 days before calving have shown that in the studied animals blood counts are different, which indicates an arithmetic mean error (Table 1).

For assessing the influence of blood parameters before delivery on the delivery process and the postdelivery period, the gradients of these periods were studied. During the research, the following data have been obtained (Table 2).

During the study it was found that 12 cows had postdelivery complications, including 6 cows, in which postdelivery complications were the result of placenta retention.

The main forms of postdelivery complications were found: subinvolution of uterus - in 12 cows, which is 30.00%; and acute postdelivery endometritis - in 4 cows, or 10.00%.

Based on the research, a comparative assessment of blood parameters was made before delivery in animals with normal course of delivery and the postdelivery period with the gradient of blood in the cows with pathology delivery and postdelivery complications (Table 3).

The blood tests' results showed that there were significant differences depending on the course of delivery and the postdelivery period by a number of morphological, biochemical and immunological parameters of cow blood.

Thus, Table 3 shows that the contents of hemoglobin and erythrocytes in the blood of cows with pathology of delivery and the postdelivery period was significantly lower than those in cows in group one by 11.94 g/l ($P<0.05$) and 10^{12} ($P<0.05$), respectively, compared to the animals without pathology.

There was no significant difference in the number of leukocytes, but in the animals with delivery pathology, a decreased content of leukocytes was observed, compared to the second group - $0.94 \cdot 10^9$ g/l.

The total protein content before delivery was not significantly different in both groups of animals. In cows of the second group, a decreased content of albumins with an increased level of beta-globulins were observed, compared with the first group of animals, the difference was veracious and amounted to 4.24-7% and 1.72%, respectively ($P<0.05$).

The amount of gamma-globulins in cows of the second group during the research was less than that in cows of the first group by 8.04%, the difference was statistically veracious. In cows with pathology of delivery and the postdelivery period, acidotic state was observed, as evidenced by low alkalinity reserve. Compared to the first group, the difference was 12.93% ($P<0.05$).

Table 1. Morphological, biochemical and immunological indicators of cows' blood 25-30 days before delivery (n=40)

Indicator	Background indicator	Studied group of animals
Hemoglobin, g/l	99.0-120.0	102.00±5.20
Leucocytes, 10^9 /l	4.5-12.0	8.13±1.74
Red blood cells, 10^{12} /l	5.0-7.5	5.06±0.81
Total protein, g/l	60.0-85.0	73.24±5.58
Albumins, %	30.0-50.0	43.0±4.44
Globulins, %, including:		
alpha globulins	12.0-20.0	13.91±2.51
beta-globulins	10.0-16.0	13.73±2.87
gamma-globulins	25.0-40.0	29.46±4.58
Total calcium, mmol/l	2.51	2.35±0.66
Inorganic phosphorus, mmol/l	1.48	143.0±6.21
Alkalinity reserve, vol %, CO ₂	50.0-62.0	47.45±8.05
Carotene, mg%	0.54	0.49±0.14
Immunoglobulins:		
A	191.37	134.18±9.84
M	120.0	120.60±6.04
G	1209.1	1122.00±88.79
Sugar, mg%	40.0-70.0	75.3±6.85
AST, un./l	60-80	93.14±20.08
ALT, un./l	80-100	118.40±19.12

Table 2. Progress of delivery and the postdelivery period

Indicator	Group of animals
n	40
Duration of delivery, h	8.42±1.18
Duration of heam separation, h	5.20±1.07
Heam retention, %	20.00
Postdelivery complications, %, including uterus subinvolution	40.00
postdelivery endometritis	30.00
End of uterus involution, days:	18.20±2.79
discharge of lochia	38.00±0.42
results of rectal examination	
Live weight of calves at birth, kg	34.60±2.58
Obtained calves, heads	40

Table 3. Gradients of blood (30 days before calving) in cows of the studied groups

Indicator	Group of animals	
	without pathology n=24	with pathology n=16
Hemoglobin, g/l	105.18±1.98*	93.24±3.24
Leucocytes, 10 ⁹ /l	8.01±0.12	7.07±0.32
Red blood cells, 10 ¹² /l	4.91±0.16*	3.91±0.21
Total protein, g/l	72.12±1.11	70.23±1.12
Albumins, %	43.45±0.62*	39.18±0.46
Globulins, %	56.55±0.72	52.14±0.57
including:		
Alpha-globulins	13.82±0.52	15.73±0.42
Beta-globulins	13.73±0.43*	15.45±1.60
Gamma-globulins	29.00±1.13*	20.96±0.66
Total calcium, mmol/l	2.28±0.05	2.43±0.03
Inorganic phosphorus, mmol/l	1.45±0.11**	0.33±0.08
Alkalinity reserve, vol %, CO ₂	47.91±1.89**	34.98±1.66
Carotene, mg%	0.520±0.03**	0.340±0.05
Immunoglobulins, mg/dl:		
A	125.82±2	118.86±5.33
M	116.27±2.84	94.88±5.13
G	1119.0±10.26	1106.79±31.36
Sugar, mg%	79.7±0.26	56.7±0.37
ALT, un./l	98.63±7.54	124.17±5.82
AST, un./l	73.85±4.16	96.32±8.14

The same regularity was also discovered for the levels of carotene in blood. Compared to the animals without delivery and postdelivery pathology, the concentration of carotene in the second group of animals was significantly lower before calving – 0.18 mg% (P<0.01).

In cows of the second group, a tendency was observed to decreasing the level of inorganic phosphorus in blood on the average of 1.12 mmol/g, after statistical processing, the difference proved veracious – P<0.01.

And finally, significant difference in the blood levels of immunoglobulins was noted.

Thus, in cows with pathology, compared to the animals of the first group, the content of immunoglobulins A, M, and G before delivery was below 6.96%, 21.3%, and 12.21%, respectively.

The content of sugar in the blood of animals with pathology during delivery and the postdelivery period was 23 mg% less than in those without complications during delivery and the postdelivery period.

In the group of cows where delivery had complications, indicators of enzymes ALT and AST increased veraciously, which indicated disruption of the "hepatosis" liver function. The most important indicators predicting manifestations of postdelivery complications are the following: decreased hemoglobin content, total protein, globulins, alkaline reserve, and the increased content of beta-globulins, as well as reliable excess of the threshold by the ALT and AST enzymes.

DISCUSSION

A lot of information about the morphological properties of blood does not mean unanimity of views on this issue. There are many conflicting opinions about changes in the morphological composition of blood during pregnancy, depending on the technology of feeding, keeping, reproduction, age and breed. The dynamics of these changes in animals significantly differ in terms of the pregnancy duration, which may be due to specific reactions of the organisms to the periods of pregnancy [2, 4].

The studies have revealed that blood indicators of highly productive cows 25-30 days before calving are significantly different, as evidenced by the gradient of the arithmetic mean error, but the blood properties in the animals correspond to the

general biological regularities, depending on the physiological status of the animals. Comparative assessment of delivery and the postdelivery period in the examined group of cows before calving shows that the blood parameters affect the process of delivery and the postdelivery period. Thus, the animals predisposed to pathology show a decreased content of hemoglobin by 11.94 g/l, erythrocytes – by 1.0 10¹²/l, total protein – by 1.89 g/l, globulins – by 4.41%, alkaline reserve by 12.93 vol % CO₂, and beta-globulin increases by 1.72%.

The most important humoral factors of resistance are the immunoglobulins or antibodies. Immunoglobulins are synthesized by plasma cells and are large protein molecules of globulin. These proteins make about 1% of blood, i.e. there are 10 g of them in 1 liter of blood. There are many molecules of antibodies – 2x10²⁰. In the group of cows with delivery and postdelivery pathology, the decreased content of immunoglobulins A, M, G was revealed by 6.96; 21.39; and 12.21 mg/dl, respectively, compared to animals without pathology [2, 10].

Our data are consistent with the studies of A. G. Nezhdanov, E. G. Lozova, V. I. Mikhalev, G. G. Chusova [18], P. Moretti, S. Paltrinieri, A. Giordano, A. Ferrari, A. Minuti [19], Nse Abasi, N. Etim, E. Glory Enyenihi, E. Mary Williams, D. Meti Abasi, Udoand E.A. Edem Offiong [11], P. Boro, A. Kumaresam, A. Yadav, N.M. Altupwram, and T. K. Mohanty, [20] that in cows predisposed to heam detention, the decreased content of total protein, vitamins A, C, B group, phosphorus and higher cholesterol levels are observed in blood during the pre-delivery and delivery periods.

Analysis of indicators of enzymes ALT, AST that characterize the state of liver shows that in animals with pathology it exceeds the threshold level by 20-30%.

Based on the research, it has been established that the nature of delivery and the postdelivery period in pregnant cows a month before delivery depends on blood indicators that characterize the morphofunctional state of the animals' organisms.

CONCLUSION

Thus, the low content of hemoglobin and erythrocytes, carotene, and alkalinity reserve, the low level of albumin with the increased content of beta-globulins in high-producing cows, as well as the disruption of synthesis of immunoglobulins A, M, and

G indicate the deteriorated redox processes and the resistance of the organism, and are predisposing factors for development of postdelivery pathology as evidenced by the data of studying the process of delivery and the postdelivery period in animals.

The obtained data complement the data about cattle blood parameters, depending on the physiological state, and bring new additions to the use of hematological parameters into the clinical obstetric practice.

The hematological parameters of cow blood taken 25 to 30 days before delivery may be not only a criterion for predicting complications during delivery and the postdelivery period, but will also allow developing a set of measures for their correction.

It is the first time that the morphobiochemical, immunological, enzymatic parameters of blood taken from cows 25-30 days before delivery were studied comparatively with regard to the progress of delivery and the postdelivery period, and the main indicators of the blood were identified that affected the process of preparation to delivery and the process of delivery, which was a new contribution into the global and domestic science for developing methods of preventing delivery and postdelivery complications in cows in the conditions of intensive milk production technology.

THE PROSPECTS OF FURTHER RESEARCH.

Subsequent works will develop measures for preventive care of delivery and postdelivery pathologies in cows by using blood parameters 25-30 days before calving. This will require continued research for veracious determination of the threshold changes in hemoglobin content in the blood, total protein, globulins, alkalinity reserve, beta-globulins, ALT and AST enzymes with regard to the animals' keeping and feeding technology.

REFERENCES

- [1] Denicola, D.B., Advances in hematology analyzers. *Top. Companion. Anim. Med.*, 2011; 26(2): 52-61
- [2] Aoki, T., Honda, H. and Ishii, M., Immunologic profiles of peripheral blood leukocytes and serum immunoglobulin G concentrations in perinatal mares and neonatal foals (heavy draft horse). *J Equine Vet Sci.*; 2013; 33: 989-995.
- [3] Safa, S., Soleimani, A. and Heravi M.A., Improving Productivt and Reproductive Performance of Holstein dairy cows through dry period management. *Asian Australasian Journal of Animal Sciences*, 2013; 26(5): 630-637.
- [4] Giuseppe, M., et. al., Effect on different Enviromental conditions on Some Haematological Parameters in Cow. *The Journal of National Research Institute of Animal Production*, 2014; 14(4): 947-954.
- [5] Adili, N. and Melizi M., Preliminary study of the influence of red blood cells morphometry on the species determinism of domestic animals. *Vet. World.*, 2014; 7(4): 219-223.
- [6] Santos, J.E.P. and Ribeiro, J.E.P., Impact of animal health on reproduction of dairy cows. *Animal Reproduction*, 2014; 11(3): 254-269.
- [7] Idrees, A., Chaudhary, Z.I. and Younus, M., Hematological and Serum Biochemical Alteration in Cattle and Buffaloes Suffering from Natural Infection of Black Quarter. *Global Journal of Medical Research Veterinary Science and Veterinary Medicine*, 2013; 13(2), 11-18.
- [8] Oyawoye, B. M. and Ogunkunle, H. N., *Biochemical and hematological reference values in normal experimental animals*. New York: Masson, 2004, pp. 212-218.
- [9] Grigorieva, T. E., Kletochnie i gumoral'nie faktori nespsitifikeskoj rezistentnosti u korov pri beremennosti i posle rodov [Cellular and humoral factors of nonspecific resistance in cows during pregnancy and after delivery]. *Veterinary of agricultural animals*, 2016; 3: 37.
- [10] Kaneko, J.J., Harvey, W. and Bruss, M.L., *Clinical biochemistry of domestic animals*. 6th edition San Diego California: Academic Press, 2008, pp. 889-895.
- [11] Nse Abasi, et. al., Hematological Parameters: Indicators of the Physiological Status of Farm Animals. *British Journal of Science*, 2013; 10: 33-45
- [12] Lobodin K. A., et. al, Metabolicheskii disbalans kak obshepatologicheskii faktor razvitiya poslerodovogo metrita u visokoproduktivnih molochnih korov [Metabolic imbalance as a general pathological factor in development of postdelivery metritis in high-yielding dairy cows]. *Scientific notes of the educational institution Vitebsk State Academy of Veterinary Medicine honored by of the Badge of Honor*, 2017; 53(2):111-115.
- [13] Nse Abasi, N., Hematological Parameters and Factors Affecting Their Values. *Agriculture Science*, 2014; 2(1): 37-47.
- [14] Nezhdanov, A. G. and Lobodin K. A., Vosproizvodstvo visokoproduktivnogo molochnogo skota: effektivnost veterinarnogo kontrolya [Reproduction of high producing dairy cattle: efficiency of veterinary control]. *Dairy industry*, 2015; 11: 64-65
- [15] Wood, D. and Quiroz-Rocha G. F., *Normal hematology of cattle*. In: *Schalm's Veterinary Hematology*. 6th ed., Iowa USA: Wiley-Blackwell Publishing Ltd., Ames, 2010, pp. 829-835.
- [16] Yolov, S.A., et. al., Investigation on some biochemical parameters and effect of hormonal treatment in anoestrous dairy cows with cystic ovarian follicle. *Asian Pacific Journal of Reproduction*, 2014; 3(1): 41-45.
- [17] Konopeltsev, I. G., et. al., Immunobiohimicheskie pokazateli sivorotki krovi korov-pervotelok pri poslerodovom ostrom endometrite i chuvstvitelnost videlennoi mikroflori k ozonirovannoi emulsii [Immunobiochemical indicators of blood serum in heifer cows in case of postdelivery acute endometritis and sensitivity of isolated microflora to ozonated emulsion]. *Scientific notes of the educational institution Vitebsk State Academy of Veterinary Medicine honored by of the Badge of Honor*, 2017; 53(1): 108-112.
- [18] Nezhdanov, A. G., et. al, Bioelementnii sostav krovi i narushenie embrionalnogo razvitiya u molochnih korov [Bioelement blood composition and disruption of embryonic development in dairy cows]. *Veterinary Medicine*, 2016; 10: 28-32.
- [19] Moretti, P., et. al. Early postpartum hematological changes in Holstein dairy cows. *Animal Reproduction Sciens*, 2015; 152: 17-25.
- [20] Boro, P., Kumaresam, A., Yadav, A., Altupwram, N.M. and Mohanty, T.K., Alteration in peripheral blood concentrate on of certain proinflammatory cytokines in cows developing retention of fetal membranes. *Animal Reproduction Sciens*, 2015; 35(7): 11-16.