Physiological response of the morphological characteristics of mammalian blood to the intake of selenium preparations into the body

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Abstract. In the course of numerous studies, the great importance of the trace element selenium for the optimum organism of mammals, including those that are farm animals, has been recognized. Therefore, in modern studies, special attention is paid to the study of the presence of selenium in the diet of animals and parallels are drawn between the level of selenium in feed and the state of the productive and breed characteristics of different animals. Enrichment of feed with selenium in males of different animal species seems promising. The influence of some selenium-containing preparations on the cellular composition of the blood of sire bulls was evaluated. It was found that when a sufficient amount of selenium is introduced into their feed in the form of selenopyran or sodium selenite, physiologically beneficial changes in the morphological parameters of blood develop. It becomes clear that in bulls-producers against the background of the introduction of tested selenium-containing agents in the feed ration, the general resistance of the organism increases, which inevitably leads to an improvement in the quality of sperm production.

1. Introduction

At present, the focus of many researchers is on the systems and mechanisms of the mammalian organism aimed at maintaining homeostasis [1,2]. Great importance in this is assigned to the blood system and its composition in relation to cellular elements and biochemical parameters [3,4]. Their stable maintenance at the optimum level is a serious guarantee of the normal functioning of the internal organs of mammals and their organism as a whole [5]. This is of particular economic importance in relation to productive animals [6]. To ensure the optimal functional state of their body, various environmental factors are assessed, one of the most important of which is considered to be a fairly adequate diet [7,8].

An insufficiently complete composition of feed in animals, especially in productive animals, can lead to a weakening of all vital manifestations, inhibition of growth, development, a decrease in productivity, weakens all manifestations of natural resistance in an adult livestock and in young animals. As a result, in productive animals, the terms of their economic use decrease and its efficiency decreases, which significantly reduces the economic efficiency of animal husbandry [9, 10].

In the modern doctrine of the mineral component of nutrition, the achievement of the optimum of mineral metabolism due to the balanced content of trace elements and their ratio with organic substances in the blood is considered very significant. In this regard, it is important to assess the needs of the animal
body for individual minerals and to develop options to meet the needs of their body in any trace elements [10, 11].

It has long been noted that the role of the trace element selenium in the body of productive animals is very multifaceted. Selenium has a great biochemical activity, very actively intensifies metabolism. It stimulates the course of tissue respiration, increases the rate of development of redox processes and activates immune processes in the body. In the case of a lack of it in the diet, inhibition of the growth and development of young animals develops, the level of productivity falls and the reproductive qualities of all animal species significantly deteriorate, largely due to metabolic disorders in their bodies.

At the same time, the microelement selenium is very often among the deficient for farm animals in Russia. This is of particular interest to physiologists and biochemists in Russia and abroad. Therefore, the question of the possibility of using selenium in the form of various feed additives in the diet of various productive animals is becoming increasingly acute [11].

The high biological significance of selenium for metabolic processes proves the urgent need for further improvement of the standard diets of productive animals in relation to this trace element. In this regard, in modern conditions, it is very important to further identify the main aspects of selenium nutrition for farm animals, which should be done taking into account the productive and breed characteristics.

Modern researchers have found a connection between the sufficiency of all trace elements in the diet of animals and the optimum composition of their blood [12]. Special attention of researchers of blood is associated with the extreme importance of its role in the vital activity of the organism and its ability to act as its marker [13]. In addition, together with lymph, the blood forms a circulating fluid system, which unites metabolic processes in all organs and tissues [14]. The composition of blood is considered as a reflection of the sufficiency of the mineral composition of the animal organism [15]. This is due to the cellular composition of blood and the peculiarities of its biochemical parameters, closely related to tissue parameters [16]. The amount of hemoglobin, erythrocytes, leukocytes and platelets in the blood, which can affect metabolic activity due to their participation in the exchange of gases and substances and microcirculation processes, are considered to be very significant parameters of the level of oxidative processes in the body [17, 18]. Objective: to consider the physiological reaction of mammalian blood parameters to the intake of selenium in the body as part of individual preparations.

2. Materials and methods
The research carried out was carried out in strict accordance with the ethical principles established by the European Convention for the Protection of Vertebrates used for Experimental and Other Scientific Purposes (adopted in Strasbourg on March 18, 1986 and confirmed in Strasbourg on June 15, 2006).

The study was carried out on 16 black-and-white bulls in several stages. After taking into the study, the animals were observed for two months - this stage was the first and control stage. Then, for two months, selenopyran was used in bulls as a source of selenium, which was administered to the animals with food for 60 days - this is the first experimental stage. This was followed by a break of two months, after which selenopyran was used by introducing it into the feed of bulls - this was the second experimental stage of the study. For the next three months, bulls did not receive selenopyran in the feed, and the next two months were considered the second control stage before using the new selenium-containing preparation. Subsequently, as a source of selenium in the study, sodium celetin was used, which was given to bulls from feed for 60 days - the third experimental stage. Then a break was made for two months, and after that, at the fourth experimental stage, the use of this drug was repeated again. The dosage of both selenium-containing preparations was carried out so that the bulls received 0.5 mg per head per day.

At all stages of the study performed, the included sires received a fully balanced diet. It consisted of fresh hay, all the necessary concentrates, sugar, chicken eggs.

All bulls were bled from the tail vein prior to feeding at the end of all stages of the study. The first blood sampling was carried out before the introduction of the first selenium-containing agent into the diet, and then at the end of each stage of the study. In the blood of animals, the content of hemoglobin,
erythrocytes, leukocytes and platelets, as well as hematocrit and leukocyte counts were recorded by traditional methods. The concentration of hemoglobin was detected using the hemoglobin cyanide method. In traditionally stained blood smears, the number of individual forms of leukocytes was counted to determine the state of the leukocyte formula. Statistical processing of the obtained data was carried out using Statistics for Windows version 6.0 (Microsoft Excel). Differences in the data were considered statistically significant at p <0.05.

3. Research results and discussion
The initial recorded blood parameters of the examined bulls (stage of the first control) were at the lower limit of the physiological norm. Thus, the number of erythrocytes in their blood was \(8.0 \pm 0.06 \times 10^{12}/l\). The amount of hemoglobin in their blood was low and amounted to 96.4 \(\pm 1.2 \) g/l. The platelet count in the blood of bulls reached 316.7\( \pm 2.7 \times 10^{9}/l\). At the same time, at the stage of the first control, the value of the hematocrit indicator was within the generally accepted norm, amounting to 35.6\( \pm 0.7 \)%. The total number of bovine blood leukocytes at the stage of the first control was \(5.6 \pm 0.08 \times 10^{9}/l\), which indicated a consistently low, but functionally sufficient activity of their immune system.

The state of the leukocyte blood count of bulls at the first control stage corresponded to the norm. The number of eosinophils and monocytes was small and fell within the generally recognized standard values: 0.65\( \pm 0.04 \%), 2.45\( \pm 0.27 \)% and 3.8\( \pm 0.13 \)% respectively. The number of neutrophils and lymphocytes in them at the first control stage also did not go beyond the normal range, indicating the optimum work of the nonspecific and specific mechanisms of the animal immune system: 32.2\( \pm 0.26 \)% and 60.9\( \pm 0.29 \)% respectively (table 1).

**Table 1.** Reaction of the morphological parameters of the blood of bulls to the use of selenium-containing agents.

| Stages of the study | Blood parameters registered in the study, M±m, n=16 | General indicators | Leukocyte formula, % |
|---------------------|----------------------------------------------------|--------------------|---------------------|
|                     | erythrocytes, x 10^{12}/l | hemoglobin, g/l | platelets, 10^{9}/l | leukocytes, x 10^{9}/l | hematocrit, % | basophils | eosinophils | neutrophils | lymphocytes | monocytes |
| 1 control stage     | 8.0 ±0.06 | 96.4 ±1.2 | 316.7 ±2.7 | 5.5 ±0.7 | 35.0 ±0.4 | 2.45 ±0.27 | 32.2 ±0.26 | 60.9 ±0.29 | 3.8 ±0.13 |
| 1 experimental stage| 8.5 ±0.05 | 112.6 ±0.67 | 301.6 ±3.0 | 6.2 ±0.07 | 35.0 ±0.9 | 2.43 ±0.18 | 28.3 ±0.12 | 74.6 ±0.25 | 4.0 ±0.15 |
| 2 experimental stage| 8.9 ±0.10 | 120.6 ±0.9 | 274.3 ±2.5 | 6.8 ±0.06 | 36.0 ±0.8 | 2.30 ±0.24 | 24.1 ±0.36 | 68.7 ±0.21 | 4.1 ±0.09 |

Selenopyran drug

Sodium selenite preparation

2nd control stage | 7.9 ±0.17 | 97.8 ±0.81 | 322.6 ±2.7 | 5.4 ±0.12 | 36.0 ±0.9 | 0.70 ±0.04 | 2.50 ±0.28 | 32.5 ±0.22 | 60.2 ±0.32 | 4.1 ±0.26 |
| 3 experimental stage | 8.4 ±0.12 | 113.3 ±0.4 | 305.0 ±1.7 | 6.3 ±0.08 | 35.0 ±0.7 | 0.68 ±0.07 | 2.52 ±0.19 | 27.9 ±0.26 | 64.8 ±0.27 | 4.1 ±0.17 |
| 4 experimental stage | 8.9 ±0.14 | 122.5 ±0.63 | 262.7 ±1.8 | 6.9 ±0.16 | 36.0 ±0.8 | 0.72 ±0.03 | 2.48 ±0.20 | 23.3 ±0.30 | 69.3 ±0.25 | 4.2 ±0.14 |

Note: the dynamics of indicators against the background of the use of each of the selenium-containing drugs in comparison with the corresponding control stage - a \( p <0.05 \), b \( p <0.01 \). No significant differences were found between the indicators during both control stages.
As a result of the use of selenopyran in the examined bulls, a number of functionally beneficial changes in the recorded blood parameters were noted. Thus, the number of erythrocytes in their blood at the 1st experimental stage increased by 6.2%, and at the 2nd experimental stage by a total of 11.2% and reached 8.9±0.10×10^12/l.

The amount of hemoglobin in the blood of bulls as a result of the use of selenopyran in them at the first experimental stage increased by 16.8% compared with the first control stage and by 25.1% at the second experimental stage. Its level in bulls reached 120.6±0.9g/l by the end of selenopyran administration.

The level of platelets in the blood of the observed bulls gradually decreased against the background of selenopyran - during the first experimental stage by 4.9%, in total decreased by the end of the second experimental stage by 15.3% and reached the level of 274.3±2.5×10^9/l. Undoubtedly, these changes improved the microcirculation process and reduced the risk of intravascular microthrombus formation in bulls.

As a result of the use of selenopyran, the dynamics of the hematocrit index during the first and second stages of the study was not observed. This indicator remained in the observed bulls at the initial level corresponding to the norm.

The number of leukocytes in the blood of bulls during the time when they received selenopyran, gradually increased. At the first experimental stage, after the inclusion of selenopyran in the diet of animals, the level of leukocytes increased by 12.7% from 5.5±0.08×10^9/l to 6.2±0.07×10^9/l. During the second experimental stage, the total increase in this indicator was 23.6%, allowing it to reach the level of 6.8±0.06×10^9/l (p<0.01).

The parameters of the leukocyte blood count of bulls at the stages of selenopyran administration changed in terms of neutrophils and lymphocytes. The number of basophils, eosinophils, and monocytes in their blood did not significantly change, reaching 0.70±0.07%, 2.30±0.24% and 4.1±0.09%, respectively, after the second experimental stage. At the same time, the content of neutrophils in their blood gradually decreased against the background of the inclusion of selenopyran in the diet of animals after the first experimental stage by 13.8%, at the end of the second experimental stage, a total decrease by 33.0% and reaching 24.2±0.36% (p<0.01). Under these conditions, the number of lymphocytes in the blood of the animals receiving the selenopyran preparation increased during the entire period of the first and second experimental stages by 12.8% to the level of 68.7±0.21% (p<0.05). This indicated the development in bulls treated with selenopyran, an increase in the activity of the immune system in terms of its specific mechanisms [19].

The transition of the observed bulls to the second control stage was accompanied by the loss of the achieved changes and their reaching the level of the first control stage. The level of erythrocytes in their blood at the second control stage averaged 7.9±0.17×10^12/l. The amount of hemoglobin in the blood of bulls at the second control stage decreased compared to the level at the second experimental stage and reached 97.8±0.81 g/l, which was comparable to the first control stage. At the stage of the second control, the number of platelets in the blood of bulls slightly increased, reaching the level of the first control stage and being 322.6±2.7×10^9/l. The hematocrit indicator retained its stability and did not change, as during all the previous stages of observation (36.0±0.9%).

The content of leukocytes in the blood of bulls at the stage of the second control decreased slightly, reaching the level of the first control stage. By this time of observation, this indicator was 5.4±0.12×10^9/l.

At the second control stage, the state of the leukocyte blood count of bulls changed, reaching that at the first control stage. Thus, the number of basophils, eosinophils and monocytes in them remained almost unchanged and amounted to 0.70±0.04%, 2.50±0.28% and 4.1±0.26%, respectively. At the same time, the number of neutrophils in their blood increased to a level of 32.5±0.22%, reaching the level characteristic of that before the start of exposure to selenopyran. Under these conditions, in the blood of the observed bulls, the number of leukocytes decreased to the level of the first control stage and amounted to 60.2±0.32% (table).
The beginning of new experimental stages was associated with the beginning of the use of sodium selinite in the observed animals. Against this background, the number of erythrocytes of blood after the inclusion of sodium selinite in the diet of bulls reached 8.4±0.12×10^12 erythrocytes at stage 3, and 8.9±0.14×10^12/1 at stage 4. The addition of sodium selinite to the diet of bulls promoted an increase in the amount of hemoglobin in their blood: during the third experimental stage, the increase was 15.8% (p<0.05), in total by the end of the fourth experimental stage 25.2%.

The number of platelets in the blood of bulls treated with sodium selinate gradually decreased. After the introduction of this drug into their diet, the number of platelets after the third experimental stage decreased by 5.8%, and by the end of the fourth, it decreased in total by 22.9% compared to the level of the second control stage. The hematocrit index at the third and fourth experimental stages of the study did not change, demonstrating the stability characteristic of the most vital constants of the organism.

The number of leukocytes in the blood of bulls against the background of the use of sodium selinite increased at the third experimental stage by 16.7%, by the end of the fourth experimental stage by a total of 27.8% compared to the level of the second control stage. The obtained values of the total level of leukocytes were comparable with those at the first and second stages of the study, respectively.

4. Conclusion
Modern animal husbandry has received a serious demand from society about the need for further intensification of food production. Achieving high-quality repair of dairy cows herd is very important in solving this issue. The solution to this problem is possible largely by optimizing the functional status of sire bulls. It is becoming clear that this can be helped by introducing micronutrients that are often missing in it, including selenium, into their diet. In the study, the effects of its introduction into the diet of black-and-white breeding bulls of two selenium-containing preparations, selenopyran and sodium selenite, were evaluated. This made it possible to establish the comparability of their influence on the main morphological parameters of the blood of animals. Taking into account the results obtained as a result of the study on the dynamics of the amount of hemoglobin, erythrocytes, platelets, the total number of leukocytes, neutrophils and lymphocytes, we can talk about the similarity of the effect on blood parameters of both tested drugs - sources of selenium. It becomes clear that with the introduction of sodium selenopyran or selenine into the diet of sire bulls, it is possible to similarly optimize their functional status, increase the resistance of their body, and thereby increase the quality of sperm production.

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