Features of blood morphological and biochemical parameters of yaks of the new Bay-Talsky type in the Republic of Tyva

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Abstract. The purpose of this research was to study the morphological and biochemical parameters of Bay-Talsky type yaks bred in the Bay-Tal yak breeding enterprise located in the Bay-Taiga mountain range. The Bay-Tal type yak was created on the basis of purebred breeding in the Sarlyk breed in 2021. 43 heads of yaks of 18 months of age were used as experimental animals, from which two groups of yaks were formed, of which 23 heads of a new intra-breed Bay-Tal type and 20 heads of yaks of the Sarlyk breed. Of the yaks indicated in this experiment, blood counts were previously studied only in yaks of the Sarlyk breed. We have conducted the study of morphological and biochemical parameters of the Bay-Tal type yaks for the first time. As a result of the study, it was revealed that the average values of blood parameters in yaks were within the physiological norm. Nevertheless, the Bay-Tal yaks showed a higher level of hemoglobin – by 9.8% ($P<0.05$), the content of erythrocytes – by 10.9% ($P<0.05$) and leukocytes – by 34.4% ($P<0.01$) compared with Sarlyk yaks. Along with morphological parameters, the yaks of the new Bay-Tal type are characterized by a high content of biochemical blood parameters: total protein - by 16.4% ($P<0.05$), urea – by 40.6% ($P<0.01$), cholesterol and glucose – by 60% ($P<0.001$). The results obtained are important for establishing the average population level of a number of morphological and biochemical blood parameters in Bay-Tal yaks.

1 Introduction

The Republic of Tyva is one of the livestock-breeding regions of Russia, part of the Siberian Federal District. The region is located in the geographical center of Asia, at the junction of the Siberian taiga and Central Asian desert–steppe landscapes, in a wide band of mountains and intermountain plains [1].

The territory of the republic according to I.M. Krasnoborov et al. (2002) is a unique place not only in Russia, but also all over the world. It is part of the Altai-Sayan mountain

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region, and is included among the 200 world ecoregions with an amazing variety of distinctive plant and animal species.

The natural conditions of the region are favorable for the management of pasture cattle breeding. Here, residents of high-altitude areas have been engaged in the cultivation of unique yak animals for centuries.

Yaks (*Bos grunniens*) are native to the highlands of Asia and are well adapted to extreme, harsh climates [3]. A unique physiological feature of which is to survive in these conditions using limited pasture resources.

The number of yaks varies according to scientific literature; some sources give data of 13-15 million of which 13 million are in China [4-5]. According to others, there are from 16 to 17.5 million heads in the world, 95% of which are in China, including 15-20 thousand wild representatives of yaks [6-7].

The main area of the yak is the territories of Central and Southeast Asia (Mongolia, China, India, Nepal, Afghanistan, Pakistan, Tibet, etc.), CIS countries: Kyrgyzstan, Tajikistan, Uzbekistan and the Russian Federation: Altai, Buryatia, Tyva, Kabardino-Balkaria, Karachay-Cherkessia and the Chechen Republic [8-10].

Many egg-growing regions are characterized by harsh natural and climatic conditions: excessive altitude (2000-5000 m above sea level), low air temperature and partial oxygen pressure, strong winds with blizzards, thick clouds and intense solar radiation. The average annual temperature is often 2.5°C and below 0°C, with an average precipitation of 440 mm [11-14].

Despite the difficult natural and climatic conditions, these animals, due to the physiological characteristics of their body, adapted to the harsh environmental conditions. Yaks play an important role in the development of nomadic peoples living in the highlands, provide the necessary products: meat, milk, butter, wool, hides, contribute to the development of these mountainous territories and population growth in these hard-to-reach territories [15].

The yak survives in extremely difficult environmental conditions due to its body's ability to adapt due to physiological reactions: vasodilatation, synchronization of energy production and energy consumption, increased levels of antioxidant metabolites and energy substrates [16-18].

The study of the blood pattern of a yak constantly living in extreme conditions of the highlands provides the necessary material for understanding the peculiarities of the physiological processes associated with adaptation, as well as improving the health, productivity and rational use of these animals [19-20]. In this regard, the study of morphological and biochemical blood parameters characterizing the direction of metabolism, the state of health and the ability of these animals to adapt to harsh keeping conditions is relevant [21].

Based on this, the purpose of our study was to study the morphological and biochemical composition of the blood of yaks bred in the Republic of Tyva.

2 Material and methods

Experimental work was carried out at the Bay-Tal yak-growing enterprise, which is located in the Bay-Taiga mountain range. The main production area of the district is agriculture, with the predominant development of animal husbandry.

The relief of the enterprise territory belongs to the mountainous type, with a predominance of medium and low mountain ranges, the climate is sharply continental. The ambient temperature in winter can reach minus 52°C, the average summer temperature is plus 18 to 35°C [22].

Laboratory analyses were performed at the Tuva Scientific Research Institute of Agriculture and at the Republican Veterinary Laboratory in 2023. Generally accepted methods and devices were used for the research: the BS-2800 Vet veterinary hematology analyzer (Mindray) and the BiAn-E 9343 programmable biochemical analyzer.

The objects of research were 43 heads of yaks aged 18 months. Two groups of yaks were formed to determine the hematological and biochemical status according to the principle of analogues. 20 heads of Sarlyk yaks and 23 heads of a new intra-breed Bay-Tal yak type. The Bay-Tal type yak was bred in the Bay-Tal yak breeding enterprise by the method of purebred breeding of the local yak of the Sarlyk breed.

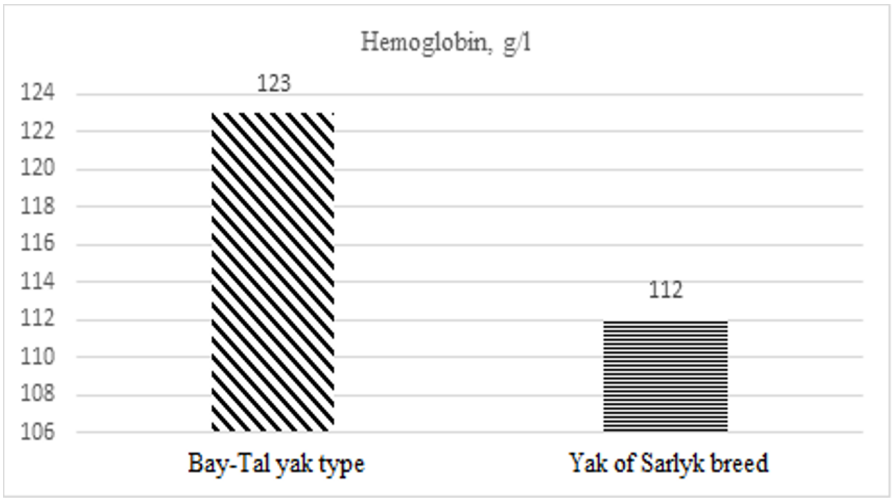
During the experiment, the yaks were in conditions of full pasture maintenance in high-altitude alpine meadows. As a top dressing, they were given salt-lick. Blood for research was taken from the jugular vein in the morning on the basis of tribal cards and certificates. Statistical processing of the obtained results was carried out using the MS Excell 2003 and SnedcorV4 software packages.

3 Results and discussion

3.1 Morphological indicators

The results of the analysis of blood morphological parameters showed that the level of hemoglobin and red blood cells corresponded to physiological parameters. Nevertheless, these indicators were 9.8% and 10.9% higher ($P<0.05$) in yaks of the Bay-Tal type than in their peers. The high content of hemoglobin with an increased number of red blood cells in the blood of the Bay Tal type yaks indicates a high oxygen capacity of the blood, which ensures more efficient transportation of gases and an intensive course of metabolic processes in the body of these animals (Figure 1-2).

The main role of red blood cells is to maintain the body's homeostasis. They are closely related to hemoglobin, which provides the body with oxygen, performing a transport function. The concentration of hemoglobin in red blood cells is influenced by factors such as prolonged stay of yaks at high altitude, the condition of hematopoietic organs and excess levels of red blood cells [23-24].



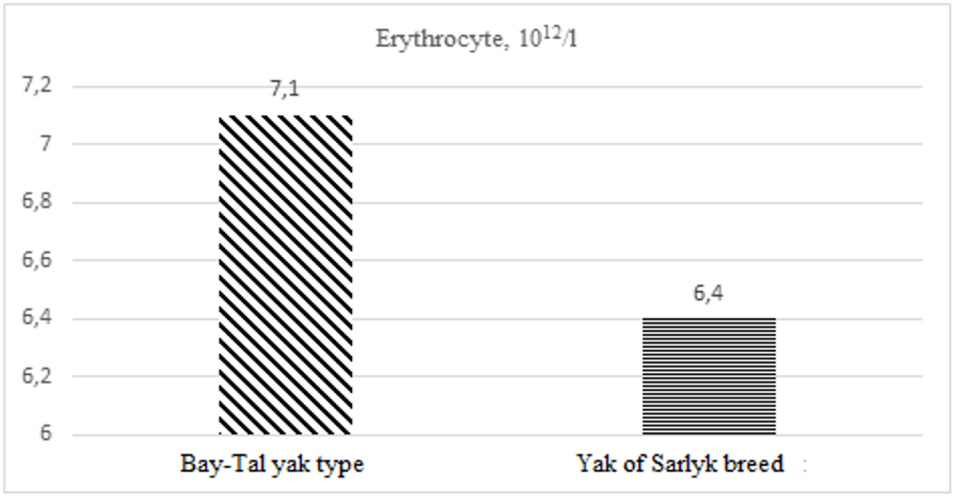


Fig. 1-2. Hemoglobin level and erythrocyte content in the blood of yaks.

The level of leukocytes in the blood reflects the protective function of the body and the state of natural resistance and characterizes the immunological reactivity of the body [25]. The content of leukocytes in the blood of the yaks studied by us is shown in Figure 3.

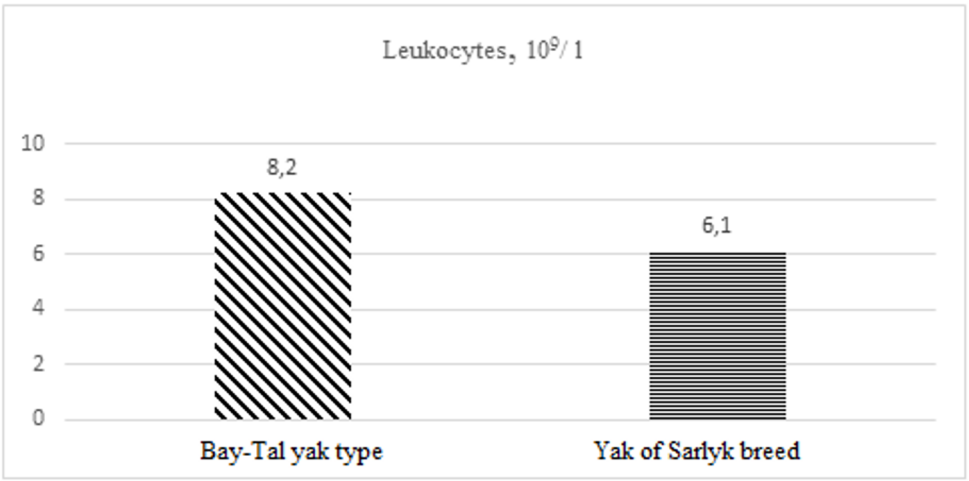


Fig. 3. The content of leukocytes in the blood of yaks.

As the data in Figure 3 show, the number of leukocytes in yaks was within the physiological norm. Nevertheless, their number in the blood of the Bay-Tal type yaks was higher, by 34.4% ($P<0.01$) than that of their analogues, which apparently characterizes their higher level of immunological reactivity and lability of the body.

3.2 Biochemical parameters

Biochemical blood parameters are indicators of the level and intensity of metabolic processes in the body of animals, and their variability is within certain limits. The determination of these indicators can be used to assess growth rates, metabolic rate and compare the physiological parameters of animals of different genotypes. [26]. According

to the literature, the biochemical parameters of yaks vary depending on a number of factors, such as breed, genotype, breeding conditions, age, etc. [27-30].

Analysis of the biochemical parameters of Sarlyk and Bay-Tal type yaks showed that the level of total protein in the blood serum of Bay-Tal type yaks was 16.4% higher than that of Sarlyk yaks ($P<0.05$), which is probably due to a more intensive metabolism and high-quality assimilation of feed protein (Figure 4).

An increase in the level of total protein also had an effect on urea parameters, its content in the blood serum of Bay-Tal type yaks was 4.67±0.13 mmol/l, which is 40.7% more than in peers of the Sarlyk breed ($P<0.001$) (Figure 5).

Urea, as it is known, is the main product of nitrogen metabolism, and its high content in the blood serum of yaks of the Bay-Tal type at normal values of other biochemical blood parameters is probably due to the high digestibility of feed protein.

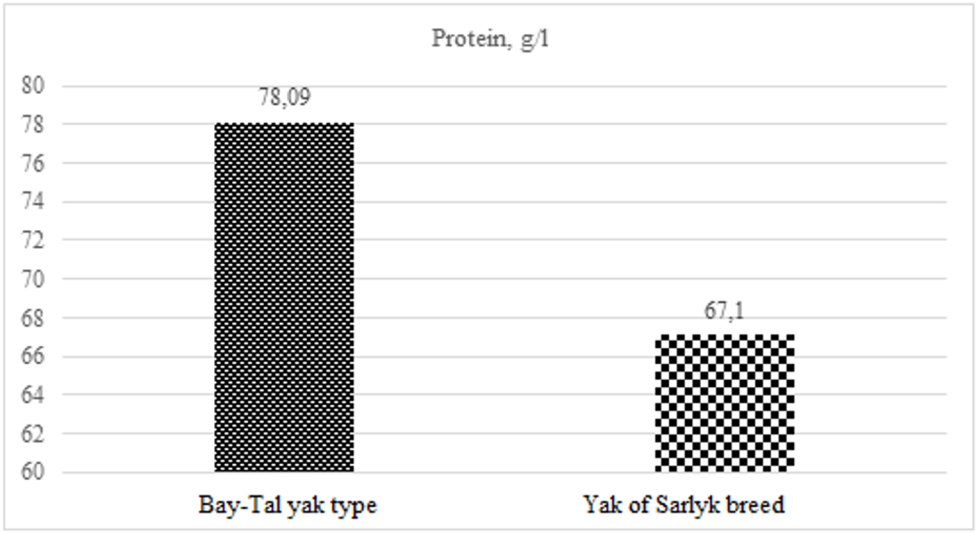


Fig. 4. The protein content in the blood serum of yaks

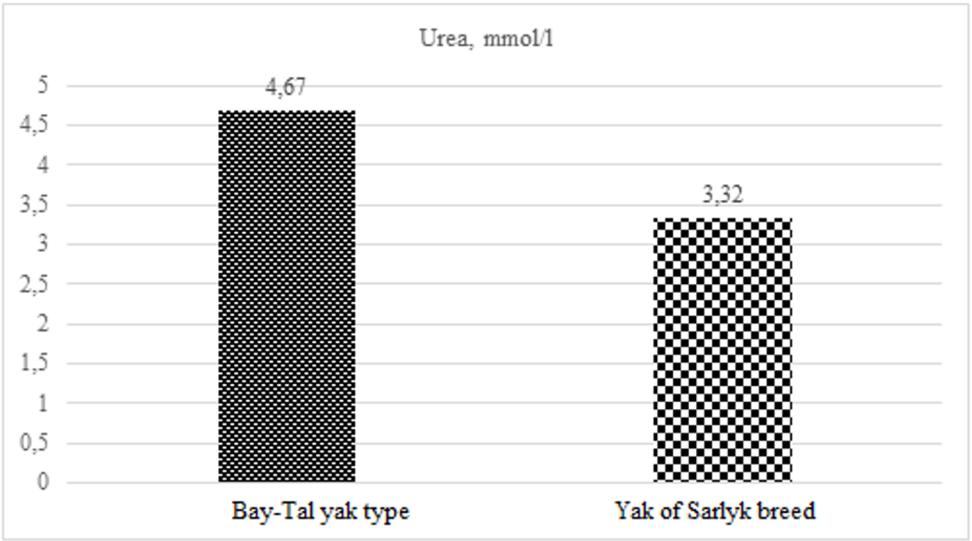


Fig. 5. The urea content in the blood serum of yaks.

The cholesterol content of the examined yaks in the two groups of yaks was within the average values, which were 3.86±0.21 and 2.38±0.19 mmol/l, nevertheless, its level in the Bayt-Tal type yaks was closer to the upper limit of the physiological norm (Figure 6).

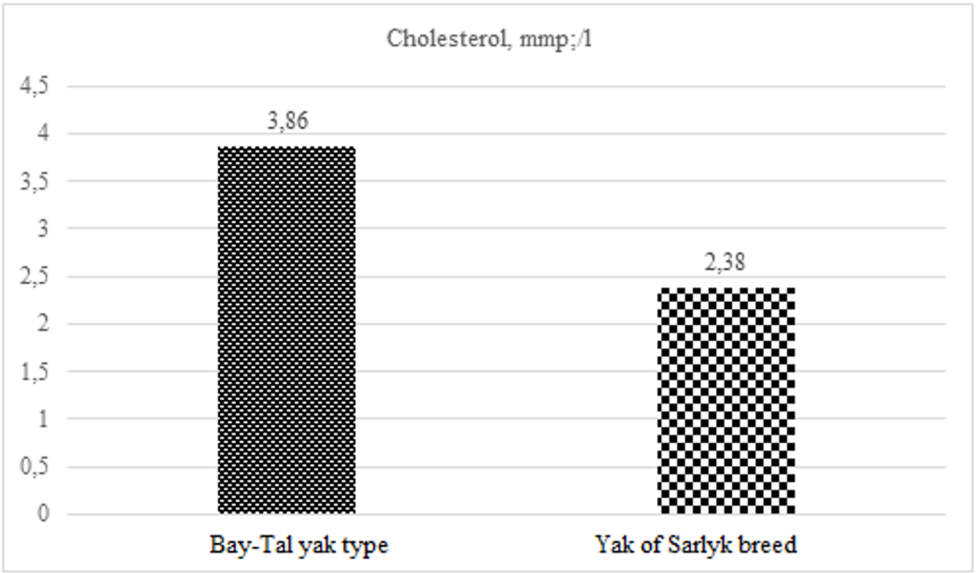


Fig. 6. The cholesterol content in the blood serum of yaks.

The main indicator of carbohydrate metabolism is the concentration of sugar in the blood, mainly glucose and its level in the blood of ruminants, is low, but quite stable and is maintained in healthy animals in the range of 2.2-3.3 mmol/l [31]. In our studies, the serum glucose level in yaks of the first and second groups of yaks was within the normal range and amounted to 3.67±1.17 and 2.29±1.24 mmol/l (Figure 7).

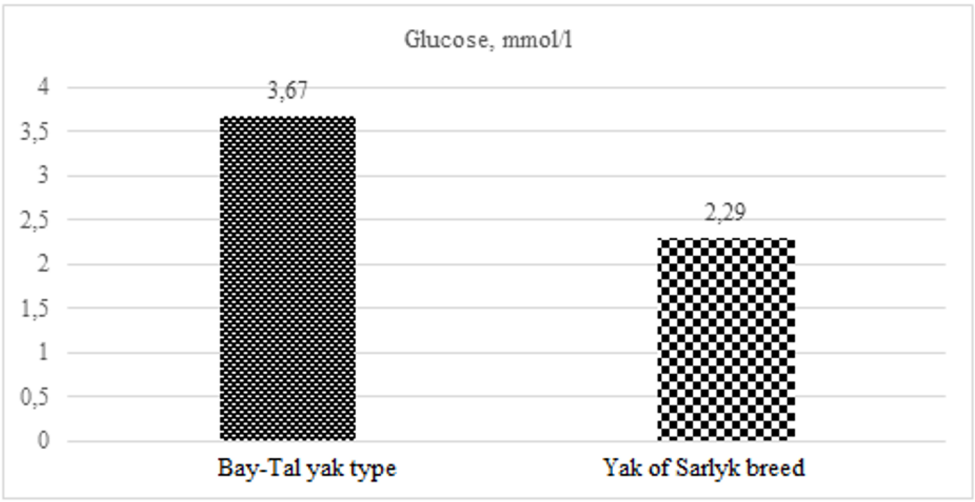


Fig. 7. The glucose content in the blood serum of yaks.

At the same time, the glucose content of Bay-Tal yaks was 60% higher than that of Sarlyk yaks ($P<0.001$), which was probably caused by the activation of carbohydrate

metabolism and the breakdown of easily digestible and carbohydrate-rich pasture feeds in the rumen.

Calcium is in balance with phosphorus, and actively participates in many biological processes of the body, has a significant impact on the growth and development of animals. It was noted that the calcium content in the blood of the examined yaks was 2.86± 0.12 and 2.77±0.09 mmol/l, which corresponds to the physiological norm, which is in the range of 2.5-3.13 mmol/l (Figure 8).

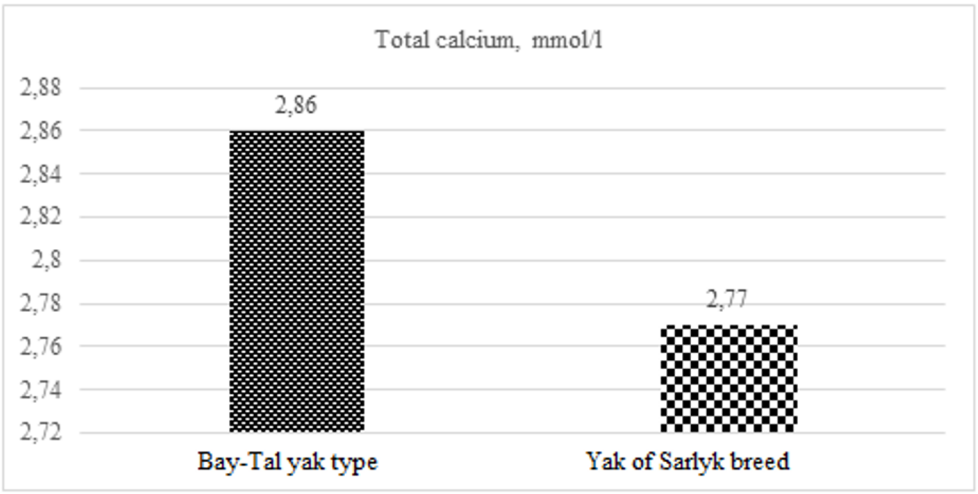


Fig. 8. The content of total calcium in the blood serum of yaks.

Phosphorus is an essential macronutrient involved in almost all physiological processes that ensure the normal functioning of the animal body, in particular, regulate the absorption of vitamin D and glucose, responsible for metabolism and cellular energy metabolism, contribute to the rapid and effective production of carbohydrates and proteins. In our studies, the serum phosphorus level in Bay-Tal yaks showed a slight decrease from the lower limit of the physiological norm and amounted to 1.43±0.15 mmol/g, when, as in Sarlyk yaks, the content of inorganic phosphorus was 1.39±0.53 mmol/g, which is 10.34% mmol/g less than the lower the boundaries of the physiological norm (1.45-1.94 mmol/g) (Figure 9).

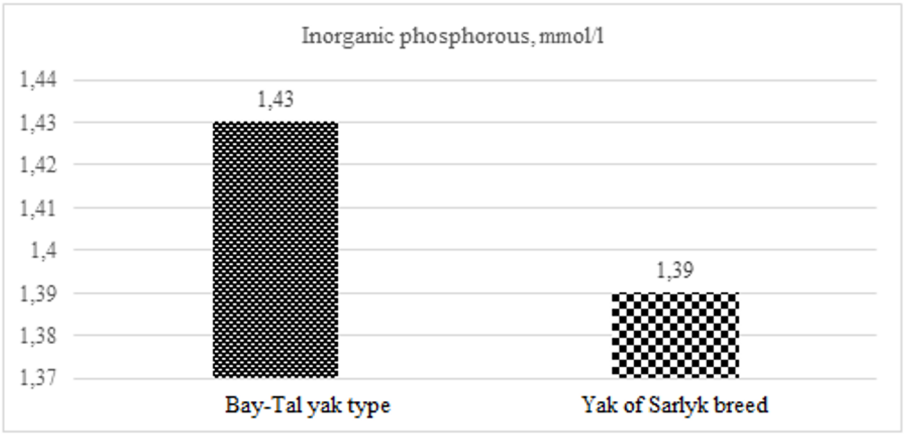


Fig. 9. The content of inorganic phosphorus in the blood serum of yaks.

Reserve alkalinity is one of the indicators of the acid-base state of the blood. The normal value of this indicator in cattle blood in general is 500-600 mg%, in meat breeds of cattle - 456 mg%. The results of the studies showed that the level of alkaline reserve in the examined yaks was within the limits of acid-base equilibrium – 518.70±11.23 and 514±9.25 mg/% (Figure 10).

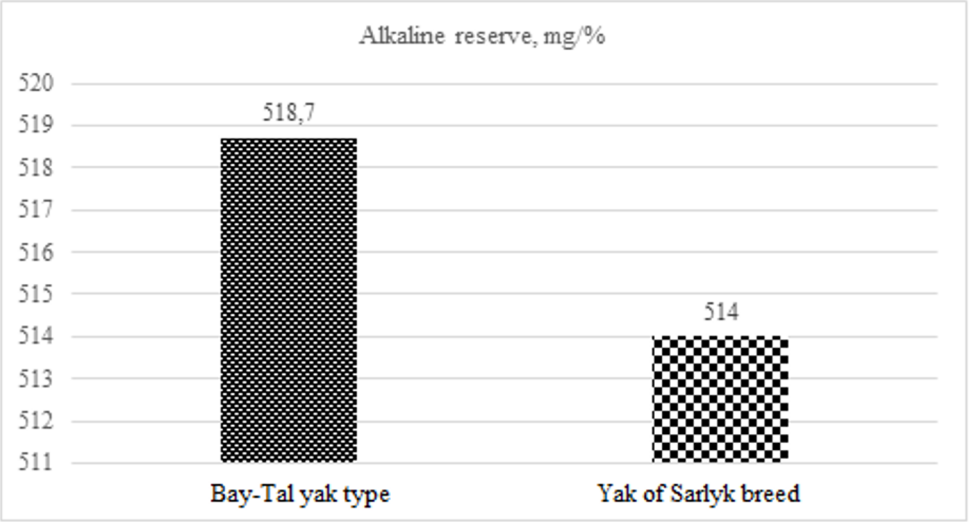


Fig. 10. The content of the alkaline reserve in the blood serum of yaks.

The results of our study on the determination of the calcium-phosphorus ratio showed that the ratio of calcium and phosphorus is 1.94:1, at a rate of 2:1, which positively characterizes the balance of mineral nutrition in the examined yaks, during their stay on high-altitude alpine pastures, pasture grass, which is characterized by a rich content of these elements.

4 Conclusions

Thus, the results of studying the morphological and biochemical parameters of the blood of yaks showed that yaks of the new Bay-Tal type had a higher level of hemoglobin - by 9.8% ($P<0.05$), the content of erythrocytes – by 10.9% ($P<0.05$) and leukocytes – by 34.4% ($P<0.01$) according to compared with the yaks of the Sarlyk breed, which indicates a more intensive course of oxidative and reductive processes in them and a high immunological reactivity of the body. Along with morphological parameters, the yaks of the new Bay-Tal type are characterized by a high content of biochemical blood parameters: total protein - by 16.4% ($P<0.05$), urea – by 40.6% ($P<0.01$), cholesterol and glucose – by 60% ($P<0.001$). Differences in some biochemical parameters were within the limits of normative values. The results obtained are important for establishing the average population level of a number of morphological and biochemical blood parameters in Bay-Tal yaks.

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