Regular changes in hematological and biochemical indicators and immunogenetic certification of yak blood introduced in new conditions

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Abstract. Yaks are unpretentious and extremely hardy. They have a well-developed sense of smell, thick hair which helps them endure harsh climatic conditions. They can live in high mountains and hilly steppes. The aim of the article is to assess adaptive properties of yaks based on morphological and biochemical studies of blood samples and immunogenetic certification by blood groups. Cattle breeding is successfully developing in the Transbaikal Krai. However, yak breeding is a new activity. In 2015, 53 breeding yaks were purchased in the Oka district of the Republic of Buryatia and exported to the Transbaikal Krai. The experimental studies on blood of transported animals identified the high content of leukocytes and the high level of hemoglobin. The lymphocyte, monocyte and red blood cell indicators were within the norm. The calcium content decreased by 0.17 mmol/l. The ratio of calcium to phosphorus was 1: 1.8. The protein content was 72.35 g/l, alkaline reserve – 51.8 v%. The indicators were within the norm. While determining the frequency of individual blood antigens, it was found that the most frequent groups were as follows: J' - 52%, X2 - 50%, Z - 49%, D' - 48%, A2 - 47%, V - 32%, G2 - 28%, F - 26%, E - 23%, O2 - 22%, P - 20%. In new conditions, the Oka yaks have high adaptive properties and productive qualities.

1. Introduction
In Russia, improvement of the livestock system is a crucial task. Breeding is one of the urgent problems in the animal husbandry. By their economic efficiency, yaks can be an alternative to cows. There is no information about their productivity and biological features. Yak breeding is one of the promising areas.

Yaks are moved from one habitat conditions to other ones. They are transported to Siberia, Yakutia, Primorye Krai, and Alaska. In Mongolia, yaks are bred in steppes [7].

Yaks can eat grass of low-yielding pastures, flat-mountains, slopes, gorges and forest edges. Being at a lower level of domestication, the yak has not lost its pronounced ability to survive in extreme conditions and satisfies the human need for biologically full-fledged food products and forcible power [3].

Yaks are unpretentious and extremely hardy. They have a well-developed sense of smell, thick hair thanks to which they can endure harsh climatic conditions. They can live in high mountains and hilly steppes.
The most important factor for cattle breeding in various climatic conditions is selection of breeds. Yak breeding is of interest. It is necessary to obtain objective data on yak adaptation abilities.

The research aims to assess hematological and biochemical parameters. The article aims at the immunogenetic blood certification for yaks introduced into the conditions of the Transbaikal Krai.

2. Experiment
Due to high adaptability to various habitats, yaks were introduced into the Transbaikal region. In 2015, 53 yaks (50 heifers and 3 bulls) were transported from the Oka district of the Republic of Buryatia. Animals were gray and black, half horned and horned. Animal identification was carried out using microchips in accordance with recommendations.

In Buryatia, yaks are bred in the spurs and valleys of the Sayan mountains and adjacent ridges, where the climate is sharply continental characterized by sharp temperature fluctuations and low rainfall. January is the coldest month; the average January temperature varies from -26 °C to -28 °C. In winter, the temperature can be -45°C. Snow melts in March. Summers are short and hot. In summer, continental polar air has a predominant effect on air masses. Spring frosts are observed in June. Early autumn frosts can be observed in August-September. July is the warmest month. The average temperature is 22–24°C, and the absolute maximum is 34–36°C.

Due to the territorial remoteness from other populations of yaks, the Oka yaks corresponds to the status of an isolate [5]. The farm which breeds yaks is located in the Transbaikal Krai at 500-800 m above the sea level in a dry-steppe zone with a sharply continental climate. The duration of the frost-free period is 90-110 days. The annual amount of precipitation is 310-330 mm. Mealy-calcareous and meadow chernozem soils are widespread there. The terrain is hilly [6].

New climatic conditions change the feeding system. The organism of animals undergoes a number of stress factors.

The research aims to study the effect of habitat changes on acclimatization and adaptive qualities of animals by bio-chemical characteristics of their blood. Blood samples were randomly selected from 10 heifers. The studies were carried out in the Transbaikal Regional Veterinary Laboratory.

Immunogenetic testing of 53 blood samples was carried out in the immunogenetic examination laboratory of the Transbaikal Regional Veterinary Laboratory using monospecific reagents of the bank of the immunogenetics laboratory of JSC “Moskovskoye” by eight blood group systems (EAA, EAA, EAU, EAF, EAJ, EAL, EAS, EAZ), including 55 erythrocyte factors. Blood was conserved using EDTA K2 and delivered to the laboratory in compliance with the selection and delivery recommendations.

Animals of similar ages and sex characteristics from the Republic of Buryatia were used for comparison. However, they lived in different conditions.

3. Discussion
Clinical, morphological, biochemical, and hematological parameters and mineral composition are among the most important systems responsible for redox processes. All these systems reflect adaptive properties of the animal.

The authors analyzed the level of leukocytes, lymphocytes, monocytes, erythrocytes and hemoglobin (table 1).

Table 1. Morphological parameters of yak blood, n=10, X±Sx

| Indicator      | Amount                  | Deviation from the norm in new conditions* | X±Sx       |
|----------------|-------------------------|--------------------------------------------|------------|
|                | Buryatia [2]            | Transbaikal Krai (authors’ research)       | Norm       |
| Leukocytes, 10⁹/l | 3,9±0,13                | 11,09±0,00                                 | до 11,0    | ±0,09                      |
| Lymphocytes, 10⁹/l | 3,99±6,88               | 3,43±0,55                                  | до 8,0     | within the norm            |
| Monocytes, 10⁹/l   | 1,13±0,20                | 0,39±0,03                                  | 0,84       | within the norm            |
When studying the samples of blood taken from animals transported into the Transbaikal Krai, leukocyteysis was observed. Leukocytes protect the body against external and internal pathogenic agents. They play an important role in typical pathological processes [2,4]. It can be assumed that animals of the Transbaikal Krai are more resistant to various pathogenic factors of the external and internal environments. Along with the same content of lymphocytes, monocytes and erythrocytes, the level of hemoglobin exceeded that in animals from the Republic of Buryatia (by 61.5%).

The increased level of hemoglobin reflects the oxygen supplying capacity of blood under stressful conditions. Stressful situations include transportation, changes in the living conditions and diet [3]. The predominant types of vegetation in natural forage lands of the Transbaikal Krai are feather-grass, sagebrush grass, bentgrass, bluegrass, and wheatgrass.

In addition, the content of calcium and phosphorus was analyzed. The calcium content was slightly below the norm and amounted to 1.93 ± 0.15 mmol/l (table 2).

### Table 2. Biochemical parameters of yak blood by territories, n=10, X±S

| Indicator                | Amount                        | Norm   | Deviation from the norm in new conditions*, ± |
|-------------------------|-------------------------------|--------|---------------------------------------------|
| Calcium, mmol/l         | Buryatia [2]                  | 2.1-3.8| -0.17                                       |
|                         | Transbaikal Krai *authors’ research* | 1.4-2.5| +0.95                                       |
| Phosphorus, mmol/l      | 1,19±0,48                     | 3,45±0,24|                                               |
|                         | 1,93±0,15                     | 1,4-2.5|                                             |
| Total protein, g/l      | 5,2±0,31                      | 72,35±1,22| 61,6-82,2                                   |
|                         | 72,35±1,22                    | 61,6-82,2| within the norm                              |
| Alkaline reserve, v%    | 83,4±0,42                     | 51,80±16,82| 46-66                                       |
|                         | 28,7±6,4                      | 46-66| within the norm                              |

Numerous studies identified that the lack of calcium and the incorrect ratio of calcium and phosphorus violate mineral metabolism. The ratio between calcium and phosphorus should be 2.0:1.0, while it was 1.8:1, i.e. the phosphorus content was higher. This increased the blood phosphorus content which amounted to 3.45 ± 0.24 mmol/l.

It is known that the lack of calcium or the predominance of phosphorus causes diet acidification. Lime was added to the diet of yaks.

An important indicator of adaptation is the content of blood protein. It is one of the indicators of amino acid metabolism which characterizes concentration of protein molecules and plasma fractions reflecting regenerative abilities of the body. If this substrate is sufficient, any organ or system is structurally and functionally complete.

The total protein content in the blood of yaks from the Oka district (83.4 ± 0.42 g / l) and the Transbaikal Krai (72.35 ± 1.22 g / l) was within the norm. The state of their immune system was normal. The next indicator reflecting the ability of blood to bind carbon dioxide is an alkaline blood reserve. This indicator increased to the norm and amounted to 51.80 ± 16.82 v%, against the original 28.7 v%.

Thus, climatic conditions influence the blood composition [5, 7]. When moving mountain animals to the lowland (from the Oka district of the Republic of Buryatia to the Transbaikal Krai), the oxidative ability of red blood cells changed and the level of leukocytes increased which indicates body adaptation to the new conditions.

Due to the lack of information about the blood group spectrum for the Oka yaks, to obtain objective characteristics of the animal genotype, analyze the genetic structure of the population, monitor its dynamics, identify the conjugacy of the allelic state of genes coding proteins, and identify the best compatibility of parental pairs, immunogenetic testing was carried out.

Some studies found that erythrocyte blood systems can be used for analysis and planning of selection processes [1].
Immunogenetic studies of 53 blood samples revealed a wide range of antigens in the blood of the Oka yaks. 35 antigens out of 55 ones participating in certification were found. The frequency of individual blood groups varied from zero to 52%.

The figure shows the frequency of the most common erythrocyte antigens to the total number of all the antigens in percentage terms (figure 1).

![Figure 1. Frequency of antigens of blood group systems in Oka yaks, %.

The study identified the most common antigens: \( \text{J}' \)-52\%, \( \text{X2} \) - 50\%, \( \text{Z} \) - 49\%, \( \text{D}' \) - 48\%, \( \text{A2} \) - 47\%, \( \text{V} \) - 32\%, \( \text{G2} \) - 28\%, \( \text{F} \) - 26\%, \( \text{E} \) - 23\%, \( \text{O2} \) - 22\%, \( \text{P} \) - 20\%. The alleles (B, I, Q, A’, I’, C) were much less common: they were identified in 10-20\% of animals. \( \text{K} \), \( \text{E3}' \), \( \text{B}' \), \( \text{G}'' \) antigens were found only in some animals, the frequency of these blood groups was 2-10\%.

Thus, the studies established the allele pool and frequency of the antigens of the blood groups of the Oka yak. The most common and rare antigens of the blood groups of eight systems were identified.

4. Conclusion

The results of experimental studies showed that the Oka yaks transported to the Transbaikal Krai were able to adapt to new climatic conditions. This indicates the possibility of introduction to improve productive and breeding qualities of beef cattle and accelerate the creation of a gene pool for breeding Oka yaks.

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