Adaptive Selection Tasks in Cattle Breeding in Yakutia

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Abstract. The article summarizes the results of the authors’ scientific works and their own research on the adaptation of Yakut cattle and their crossbreeds with the Simmental breed to specific climatic and economic conditions of keeping.

The paper highlights outstanding fat content (5.5...5.58%), excellent compensatory growth energy with free summer feeding (700...900 g per day), high coefficient of digestion of coarse feed fiber (74%), Yakut cattle’s unique resistance and adaptation to adverse weather, economic conditions of breeding, the degree of their inheritance in crossbreed livestock.

The article presents materials for studying the morphobiological composition of blood, thermoregulation, skin and hair cover, development of internal organs, gas-energy metabolism, digestibility and use of feed nutrients.

It is indicated that when crossing Yakut cattle with Simmental breed with an increase in genetic generation of crossbreeds, its valuable economic and adaptive qualities disappear.

The task of protecting the gene pool of local native Yakut cattle and increasing its livestock and geographic range, improving nutrition concerns not so much its higher productivity, but the preservation of the valuable nutritional qualities of its dairy and meat products as well as of its adaptive potential to local conditions in the offspring.

When local Simmental (87% of the population) and Kholmogorsky (12% of the population) cattle breeds are kept with generally accepted methods of artificial selection aimed at increasing productivity and improving hereditary qualities, it is necessary to simultaneously conduct adaptive selection by preserving the valuable qualities of the Yakut cattle gene pool in the offspring.

1. Introduction

To study the adaptive features of the Yakut cattle and their crossbreeds with the Simmental breed, and on this basis to determine the direction of selection and breeding work for the protection of the gene pool of local animal breeds.

2. The method of working

In our early studies, hemoglobin in the blood was determined by Sahlis method (g/%); erythrocytes and leukocytes were measured in the Goryaev chamber; total protein was measured by refractometer; protein fractions were calculated by electrophoresis on paper; bactericidal activity of serum was estimated by photonephelometric method. Skin images were taken on the point of elbow, microscopic studies were carried out in the Problem Laboratory of Hormonal Studies of the Moscow Timiryazev Agricultural Academy (Moscow).

The results of the research. The territory of the Republic of Sakha (Yakutia) with the Arctic zone is 3083.5 thousand km² and according to the geostuctural position it belongs to three large regional...
complexes: Central Siberia, Eastern Siberia and Southern Siberia. Excluding deer, agricultural land (arable land, hayfields, pastures) makes up 1.3% of the region's area.

This huge area of the republic is a home for two native breeds of domestic animals: Yakut cattle and Yakut horse.

The territory of the republic is a zone of risky agriculture and animal husbandry. Limiting factors for the development of agricultural industries are: extremely low winter air temperature (on average in January it is 31–45°C), a short frost-free period in the air (67 ... 76 days), a small amount of precipitation (250–300 mm), a long winter period during the year (220 ... 250 days).

The proceedings of the Council on Study of Productive Forces of the 1st Scientific Expedition of the USSR, in particular the paper by E. Shubsy and F. Saltykov Yakut cattle stated: “The great historical merit of the Yakuts is that they managed to move the animal husbandry border in the North up to the polar regions. The Yakuts ... made habitable such areas that, without their heroic persistent struggle with the harsh nature, would have remained uninhabited to this day.” [14]

In 1917, the territory of the republic contained 487.5 thousand heads of Yakut cattle, 133.3 thousand heads of local horses [2]. Since the 1960s, the mass absorption crossing of Yakut cattle with producers of Simmental and Kholmogorskaya breeds has almost destroyed the local breeds. Today in the republic there are less than 2000 heads of Yakut cattle, 160 thousand heads of horse of the Yakut breed. The task is to increase the number of Yakut cattle.

Outstanding economically useful features of native cattle of Yakutia are: Yakut cattle—high fat content (5.5...5.68%); excellent compensatory feeding qualities (700...900 g per day); high coefficient of digestion of dry matter of coarse feed (74%); high resistance and adaptability of the body to extreme climate and economic conditions of maintenance and reproduction [3,4,5,14].

The sharply continental climate of the region, lack of winter exercise, a meager diet in terms of volume and nutrition, of course, affect the metabolism, causing various deviations in the body of livestock.

Adaptation refers to the evolutionary process of adaptation of organisms to the environment, determined by their ability to exist in changed conditions. It is expressed by a set of physiological reactions of the body (physiological adaptation), changes in the genotype as a result of new genes that cause a new norm of reaction to ensure vital activity (genotypic adaptation).

Cattle breeding in Yakutia began as a result of the introduction of cattle from Central Asia in the north of Eastern Siberia in the 14th century by the ancestors of the Sakha people (Yakuts).

Since those ancient times, the body of Yakut cattle has been continuously exposed to the effects of evolutionary adaptation, physiological and genotypic variability of reaction norms to the conditions of existence.

At the present stage of the development of cattle breeding in the republic, the task is to protect the gene pool of Yakut cattle by increasing its population, its geographic range, and improving the culture of the industry. At the same time, the task should not be to increase the productivity of Yakut cattle, but to preserve the exceptional nutritional qualities of their products, and the adaptive potential to specific conditions of existence (adaptive selection). The need to preserve the nutritional qualities of the products of the original Yakut cattle follows from the selection work on breeding local zonal type of cattle on the basis of the existing crossbreed stock of different ecogenesis (high-blood and purebred). In the world today, the market needs marbled meat. Such meat is formed and genetically inherited, the content of thyroglobulin (marbling of meat) and calpain (tenderness of meat) in meat is determined, and it is detected by PCR analysis [15,16].

In Yakut cattle, a strong development of physical thermoregulation was noted, expressed by a decrease in the level of metabolism at moderately low temperatures (-15°C). There is a sharp reduction (by 16.2% at-31°C) of the volume of pulmonary ventilation and the amount of oxygen consumption, while in cultured breeds (central Russia), on the contrary, the oxygen consumption (chemical thermoregulation) increases (by 39%), the skin temperature decreases from 33.8 to 30.7 ° [4]. When crossing Yakut cattle with cultured breeds in the resulting population of crossbreeds, thermoregulatory processes are genetically determined.
So, our studies in the population of Simmental crossbreeds (F₁, F₂, F₃, F₄) including the winter stall period, established lower energy costs with a view to maintain the temperature homeostasis of the body. Heat loss from the respiratory tract is reduced by 2 times (respiratory rate in summer -26 ... 29; in winter -15 ... 16), evaporation from the body surface by 2–3 times (sweating in summer 470...633, in winter 200 ... 240 g / m² / h), depression of the cardiovascular system: pulse decreases by 56%, vascular response reduces by half.

In summer, the thermoregulatory mechanism in the body increases dramatically. Moreover, in low-blood crossbreeds (F₁), temperature homeostasis is supported by an increase in the function of the skin-vascular system (sweating), and in cattle of high genetic generation (F₃, F₄) it is done through an increase in clinical parameters [9].

Another adaptive feature of the Yakut cattle is its seasonal dynamics of the hair structure. In winter, the density of hair increases by 6.2 times, the structure of the number of downy hair -84.1%, transitional hair 11.2%, top hair 4.7%. In native cattle, the hairline is 3 times longer and 4 times thicker than in local crossbreeds [6]. In summer, the intensity of sweating in Yakut cows is 3 times higher than in Simmental crossbreeds [4]. Among crossbred cows of different genetic generation (F₂, F₃) in summer (23...26°C), the intensity of sweating per unit of time doubles (17 ... 21.5%), and (F₁) triples (35.7%) [7].

It is indicated that in northern domestic animals, 20% of heat release occurs in the liver, 4...6% in the heart and 4..8% in the kidneys. The body of Yakut cattle is characterized by an economical consumption of energy of fat and sugar accumulated during summer pasture. The development of internal organs of different age groups of cattle have an unequal development index (weight in % of live weight). At the age of 18 months, respectively: 0.48; 1.33; 1.32; 0.35 and 2.5 years – 0.49; 1.34; 1.18; 0.20. Since Yakut cattle are considered late-maturing, the development of internal organs continues until the age of an adult cow: liver by 21.4%; heart—18.9; lungs—7.1 and small intestine—84.2%.

Table 1. Development of the intestinal tract of Yakut cattle (A. F. Abramov, 2017) [1]

| Types of intestinal tract | Gobies at the age of 18 months | Gobies at the age of 2.5 years | Yakut cow | Thoroughbred cow |
|---------------------------|-------------------------------|-------------------------------|-----------|-----------------|
| Oblique body length (OBL), m | 1,18                          | 1,32                          | 1,38      | 2,50            |
| The total length of the intestine, m | 22,47                        | 29,62                         | 51,52     | 49,8            |
| The index of total length of intestine * (II) times | 19,0                          | 22,4                          | 37,3      | 19,9            |
| Length of the small intestine, m | 17,23                        | 21,78                         | 40,11     | 41,7            |
| Index of the length of the small intestine | 14,6                          | 16,5                          | 29,1      | 16,7            |
| II*, times | Length of the large intestine, m | 5,24                          | 7,84      | 11,41           |
| Index of the length of the colon*, times | 4,4                          | 5,9                           | 8,3       | 3,2             |

*II – length of the colon (in times) to the OBL
The development of the length of the intestinal tract is of exceptional interest in Yakut cattle: the length of the intestinal tract in native cattle exceeds the oblique length of its trunk by 37.3 times, including the small intestine—29.1; large intestine—8.3 times. These indicators in purebred cows are 19.9; 16.7; 3.2, respectively. That is why Yakut cattle digest the fiber of coarse feed well (coefficient 71.6%) and assimilate it, the consistency of feces is more solid than that of purebred crossbreed cattle (Table) [1].

The special adaptive ability of Yakut cattle to harsh conditions of keeping is expressed in the indicators of skin microstructure. Cattle have a well-developed protective (keratinizing) layer of the epidermis, a thick layer of fiber, a small papillary layer, an early onset of molting, and regenerative processes in the skin [3].

In our studies on the microstructure of the skin of a crossbred population of cattle, the best adaptation parameters were low-blood generation of cows (F1), they have a more pronounced protective layer of the epidermis and subcutaneous tissue, a network of cutaneous blood vessels. With an increase in the blood relationship of cattle, they are less pronounced.

With the onset of the summer season, there is a rapid qualitative restructuring of the skin microstructure (F1), which causes early molting, better function of the sweat and sebaceous glands than in high-blood peers (F2, F3). Thus, with an increase in the blood relationship of cultured breeds, the adaptive qualities of the skin and hair cover of Yakut cattle are gradually lost in crossbreeds [13].

Studies of many authors [3,4,7] say that compared to the local crossbred cattle, the blood of the Yakut cattle contains more hemoglobin, erythrocytes, glutamine, low activity of alkaline phosphatase is registered as well as a high rate of substitution of fatal hemoglobin of the adult type. They point to the increased intensity of the redox reaction of Yakut cattle, as one of the indicators of adaptation of cattle to extreme conditions of keeping.

In general, seasonal synchrony of physiological and biochemical rhythms of the body with the environment is an adaptive mechanism of the organism of northern cattle breeds to the climate in high latitudes. In this case, their adaptive features are manifested in the economical consumption of energy in winter and their strengthening under favorable summer feeding conditions.

G. P. Korotov [3] found that the blood of Yakut cattle is richer in hemoglobin and leukocytes, but poorer in red blood cells, while the blood of crossbred cows contained more sugar, vitamin A, and ascorbic acid.

We found that in Yakutia, in conditions of relatively low culture of cattle breeding in winter (poor nutrition, light hunger, inactivity), the protective function of the livestock body decreases [10]. In particular, in crossbred calves, the level of inter-daily metabolism in spring is low, and in summer the hemoglobin content increases by 28.4% (t=6.1; P<0.001). Moreover, the difference in blood parameters is more pronounced in calves with lower blood density by 25.7% (t=3.24; P<0.001) [9].

In deeply pregnant cows in the months of winter stall keeping, a weakening of cellular protective factors was noted – phagocyte number to 1.27%; phagocyte index to 3.26...3.47 and phagocyte activity to 30.21...32.7%, which is 55.7% lower than the permissible physiological norm of natural resistance of the body [13].

In our research and production experience, with an increase in the level of nutrition by 23.6% and an improvement in the type of diet, significant changes in the morphological and biochemical composition of blood were noted (Fig.).

The cows of the experimental group showed an increase in the redox function of the blood, the optimal content of total protein and vitamin supply of blood serum. Daily milk yield in the experimental group of cows averaged 14 kg (11.1...19.2 kg), the control group – 11.8 (8.8...14.6 kg). In the composition of milk, immune globulins increased by 9.0%, serum albumins by 1.7...1.9 [11].
Studies of E. T. Struchkov and N. E. Sidorov [13] demonstrated that Yakut cattle are better adapted to the consumption and digestion of a large amount of coarse feed with a high content (30...33%) of fiber and almost do not react to the juiciness of the diet. At the same time, in the rumen, it forms more volatile fatty acids (61.2 mmol/l), the molar fraction of acetic acid (66.5%), than in local crossbred cows.

In our scientific and economic experience, in the livestock of beef cattle, better digestibility of feed in crossbred young animals was shown by local simmentals rather than by Hereford cows. At the same time, the bulls digested fiber better than the protein of the feed and had a daily increase of 499...527 and 486 g, respectively. Consequently, with an average level of winter cultivation (widespread), industrial crossbreeding according to the simmental x Hereford scheme and the structure of the diet, coarse feed—56.4%, concentrated—41.9%, Hereford crossbreeds are less adapted and do not show their genetic productivity potential [13].

3. Conclusions
- outstanding economically useful and biological characteristics of Yakut cattle are high fat content (5.5...5.58%), excellent compensatory summer feeding qualities (700...900 g per day), high coefficient of digestion of coarse feed fiber (74%), resistance and adaptive qualities of the body to extreme climatic and economic conditions of maintenance;
  the task of protecting the gene pool of Yakut cattle, together with the increase in population the expansion of the habitat, lies not so much in increasing the productivity but rather in saving valuable food products quality, adaptive capacity to environment;
- along with the methods of generally accepted artificial selection aimed at increasing the productive and improving the hereditary characteristics of local Simmental and Kholmogorsky cattle breeds, in order to preserve the adaptive properties and nutritional qualities of the products of the original Yakut cattle in the offspring, it is necessary to simultaneously conduct adaptive selection by using the gene pool of native cattle.

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