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The Endangered Alatau Cattle Breed and its Phenotypic Characteristics in Comparison with the Brown Swiss Breed

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ABSTRACT

In recent years, local cattle populations have been replaced by highly productive breeds in the Republic of Kazakhstan, which has significantly reduced the number of local breeds. Today, two cattle breeds are on the verge of extinction, one of which is the Alatau breed, which was bred in 1950 by crossing local aboriginal Kazakh cattle with Brown Swiss cattle brought in together with immigrants from Russia. In this regard, the purpose of our work is to obtain new genotypes by backcrossing, i.e., the use of sperm from purebred bulls of the Alatau breed on high-blooded animals of the Brown Swiss breed, followed by a study of the offspring obtained for development and milk productivity in comparison with the descendants of heifers from the Brown Swiss bulls. Upon completion of the research, it was established that heifers obtained from Alatau bulls in all growth periods exceeded the indicators of heifers obtained from Brown Swiss bulls by 14.9kg at 6 months, 17.3kg at 12 months, and 16.8kg at 18 months. It was also found that the daughters of the Alatau bulls were inseminated 52 days earlier than those received from the Brown Swiss bulls. As a result, they experienced their first calving 48 days, or approximately 1.6 months, earlier than their counterparts. There is no significant difference between the indicators of milk productivity of the daughters of Alatau and Brown Swiss bulls.

Key words: Breed conservation, Biodiversity, Local cattle, Dairy productivity, Adaptability, Live weight.

INTRODUCTION

Biodiversity conservation is becoming an increasingly important task of modern biological science (Groeneveld et al. 2010; Bugubayeva et al. 2024). As genetic resources are the national and global biological capital essential for the development of sustainable agricultural production systems (Toro et al. 2009; Beishova et al. 2024).

Over the past few decades, the number of local species has declined due to the demands of intensive animal husbandry and global economic development (Tanbayeva et al. 2024). Food and Agriculture Organization of the United Nations (FAO) estimates that almost 30% of local species worldwide are threatened with extinction (FAO 2021) and Kazakhstan is no exception.

Breeds of different countries of the world differ in their specificity. A characteristic feature of Kazakhstan's cattle gene pool is its ecotypic, which is based on thousands of years of adaptive hereditary traits. In the middle of the 20th century, three breeds of cattle were bred in Kazakhstan and the basis of their breeding was local aboriginal Kazakh cattle (Kabylbekova et al. 2024).

According to Gerchikov (1958), Kazakh native cattle are a primitive breed distributed in Kazakhstan, a product of the nomadic living conditions of Kazakhs in the past. Until 1917, breeding work with Kazakh aboriginal cattle was not carried out. From 1929-1930, the crossing of this group of cattle with other breeds began (Fandeev 1955). According to Gerchikov (1958), Kazakh cattle on collective farms and state farms were subjected to mass crossbreeding and in 1953 about 70% of the livestock consisted of crossbreeds of planned breeding: Hereford, Brown Swiss, Simmental, red steppe and Ostrofriz. Among the local cattle, 41% were Hereford cattle, 11.9% Simmental cattle, 7.2% Red steppe cattle and 5.5% Brown Swiss cattle.

The formation of the Alatau breed took place in the foothills of the Zailiisky Alatau by crossing local aboriginal Kazakh cattle with bulls of the Brown Swiss breed. These bulls were brought to Kazakhstan in 1912 together with immigrants from Russia, hence the breed's eponymous name (Liskun 1951; Fandeev 1955; Gerchikov 1958; Pak 1967; Soldatov et al. 1982).

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When selecting animals for breeding the Alatau breed, an assessment was made according to a set of characteristics, with special attention paid to the use of animals with a strong constitution and high milk productivity. Since the crossbreeds of the II and III generations in terms of physique and productivity most met the requirements of the desired type, the animals of these generations were mainly used for breeding "in themselves" (Fandeev 1955). Thus, in 1950, the Alatau dairy and meat breed were tested in the Kazakh and Kyrgyz republics.

According to many researchers, animals can acclimatize to the environment and be adapted to external stressful situations, which is crucial for their survival (Collier et al. 2019; Gaughan et al. 2019; Zaitsev et al. 2024). However, the adaptive capacity of animals negatively affects the productivity and profitability of livestock systems (Mignon-Grasteau et al. 2005; Petrov et al. 2024).

According to Pak (1967), the new breed differed from the native Kazakh cattle by higher weight and milking, but with less fat in the milk. According to its shape, the new breed evolved from beef to beef, with a light to dark brown complexion. There is also information on the number and milk production of Alatau cows in 1950 and 1959 (Table 1).

Table 1: Number and average milk yield of cows in breeding farms of Kazakhstan (Pak 1967)

Lactation	1950 year		1959 year	
	Number of cows	Average yield	Number of cows	Average yield
First	681	2020	1443	2740
Second	496	2381	992	3278
Third and older	2291	2915	2590	3597

Thus, in almost 10 years, the number of cows of the Alatau breed increased by 45% and milk yield on average of 625kg or 23.4%. In 2004, the number of breeding crossbreeds of the Alatau breed reached the mark of 20,223 heads, including 8,303 cows (Sulenov and Torekhanov 2005). Thus, since the adoption of the Alatau breed in 1950, the number of breeding cows had increased by 6,012 or 3.6 times by 2004, and the productivity of animals by 1,928kg.

Therefore, over the last 50-70 years, the process of crossing local adapted populations with highly productive breeds began to develop. Crossbreeding was accompanied by a decrease in the genetic variability of the original breeds, which led to a significant reduction in the number of local breeds that until recently were actively involved in agricultural production (Rischkowsy and Pilling 2007; Scherf and Pilling 2015; Zeller et al. 2017).

Taking advantage of the situation in Kazakhstan during the transition period, the active import of sperm from bulls producing highly productive breeds (Holstein, Brown Swiss) began (Beishova et al. 2023; Petrov et al. 2024). It is fair to note that such an import of world genetics to Kazakhstan to a certain extent expanded the scope of the genetic diversity of breeds and populations of dairy cattle, positively influenced the level of productivity of the Alatau breed. At the same time, the country has practically ceased to pay attention to the evaluation, selection, obtaining, and use in the reproduction of repair bulls of their own selection, which has led to a number of negative factors associated with the absorption of the Alatau breed by Brown Swiss genetics.

Thus, the gene pool of breeding Alatau cattle, which was purposefully formed since the late 30s of the last centuries, was gradually "dispersed" and, in fact, lost its uniqueness and attractiveness (Akileva 2008). Thus, at the beginning of the XX century, the Kazakh aboriginal cattle completely disappeared in Kazakhstan, and literally 100 years later, its successor, the Alatau breed, practically disappeared.

However, artificial insemination of livestock is recognized as the leading method of widespread dissemination of desirable traits from valuable producers and some researchers have supported this method not only for the purpose of genetic management of highly productive breeds, but also endangered breeds (Bailey et al. 2000, 2003; Morrow et al. 2009; Kumar et al. 2019).

In this regard, thanks to the cryopreservation of genetic materials and its indefinite storage (Khan et al. 2021), it is possible to revive the domestic breed with their subsequent effective use for small and medium-sized farmers.

The purpose of this study is to conserve the endangered Alatau cattle breed by backcrossing it with high-blooded Brown Swiss cattle. The study objective was to obtain new genotypes through the use of sperm from purebred Alatau bulls on high-blooded Brown Swiss cows. The research also intends to compare the development and milk productivity of the offspring from these crossbreeds with those obtained from Brown Swiss bulls.

MATERIALS AND METHODS

The object of research was heifers obtained from bulls of the Alatau and Brown Swiss breeds. The animals are bred on a farm located in the foothill zone of Kazakhstan in the Dzhetysui region. In the spring, summer and autumn periods, they are kept on pasture and pasture maintenance.

The sperm of purebred Alatau bulls was purchased from the biobank of the Kyrgyz Republic. To achieve this goal, 4 groups of cows were formed on the farm, having the same proportion of blood in the Brown Swiss breed (75%). The sperms of 2 purebred Alatau bulls were used for 2 groups of cows during artificial insemination. For the other 2 groups, the sperm of purebred Swiss bulls was used. Thus, got two groups of offspring. One group with a share of blood in the Brown Swiss breed 37.5% (offspring from the Alatau bulls). Another group with a share of blood in the Brown Swiss breed 87.5% (offspring from Brown Swiss bulls).

The proportion of blood of animals of the Brown Swiss breed was calculated according to formula 1 (Sulenov and Torekhanov 2005).

$$Fp = \frac{K_1 \quad + K_2}{2} \qquad (1)$$

Where:
Fp is the proportion of bloodline of offspring;
K_1 and K_2– the proportion of blood of the parents.

Control weighing was used to compare the 2 groups' comparative characteristics according to the dynamics of body weight from birth to 18 months. The age of the first insemination and the first calving was determined from the logs of the farm's calves and calves.

Age adjustment for 6,12 and 18 months was carried out according to the formula 2,3,4:

$$M_6 = \frac{M - Mp}{K} * 180 + Mp \quad (2)$$

Where:
M_6 - is the adjusted live weight for 180 days (6 months);
M - is the live weight when weighing;
Mp – live weight at birth;
K - is the number of days from birth to the weighing date.

$$M^2 = \frac{Mf - Mp}{K} * 185 + M^{180} \quad (3)$$

Where:
M^2 -is the live weight adjusted for 365 days (12 months)
Mf – is the live weight on the date of the last weighing
Mp – is the live weight as of the date of the previous weighing
K – is the number of days between weighings
M^{185} – is the live weight, adjusted for 180 days
185 – is a coefficient is between 180 and 365 days

$$M^3 = \frac{Mf - Mp}{K} * 175 + M_{365} \quad (4)$$

Where:
M^3 - is the live weight adjusted for 540 days (18 months)
Mf – is the live weight on the date of the last weighing
Mp – is the live weight as of the date of the previous weighing
K – is the number of days between weighings
M_{365} – is the live weight, adjusted for 365 days
175 – is a coefficient is between 365 and 540 days

The milk production of the cows for 305 days of the first lactation was determined by monthly monitoring milking and taking samples of milk from everyone.

Quality composition of milk (percentage of fat and protein content in milk) from each cow was determined in the accredited dairy laboratory of LLP "Kazakh Research Institute of Livestock and Forage Production".

Statistical processing of digital values was carried out according to Merkuryeva and Shangin-Berezovsky (1983). The difference between the mean values of the two samples was estimated using the formula 5 (Moiseikina and Turdimatov 2006).

$$td = \frac{X_1 - X_2}{\sqrt{M_1{}^2 + M_2{}^2}} \quad (5)$$

Where:
td is the reliability of the difference between two values
X_1 and X_2 are an indicator of average values
M1 and M2 are the average error of the average value

The history of Alatau breeding has been studied through various literary sources.

RESULTS AND DISCUSSION

Pregnancy rates and calving outcomes from insemination with Alatau and brown Swiss bulls

A rectal examination of cows for pregnancy showed that 69.8% of 96 cows inseminated with sperm from Alatau bulls Dikar and Sedoi were fruitfully inseminated (Table 2). Cows inseminated with sperm from Brown Swiss Bulls Advisor and Koors turned out to be pregnant in total 83.8%. On average, cows inseminated with Brown Swiss bulls were 14% more fruitful than cows inseminated with sperm by Alatau bulls.

Table 2: Information regarding bulls whose sperm is stored in the biobank of the Kyrgyz Scientific Research Institute of Animal Husbandry and Pastures (Kyrgyz Republic)

No.	Bull name	No. Bull	Breed	Birth year
1	Dikar	443	Alatau	13.04.1983
2	Sedoi	742	Alatau	06.11.1992

From November 2019 to September 2020, calving controlled cows were monitored. It was noted that a group of cows inseminated with the sperm of a Dikar bull not only gave 100% calves, but even 2 cows gave birth to 2 calves each. The analysis of the obtained data showed that 65 calves or 97% were obtained from 67 fruitfully inseminated cows, bulls of the Alatau breed, and 70 calves or 89.7% were obtained from a group of fruitfully inseminated Brown Swiss bulls (78 heads), which was 7.3% lower than the indicator of inseminated cows Alatau bulls. The undeveloped offspring of a total of 12 heads was lost because of premature miscarriage, severe labour, and two heads fell immediately after birth.

Thus, by backcrossing, 65 genotypes were obtained that have a unique value in global genetic diversity, which have unique adaptive properties of the local environment. Of the 65 offspring obtained, 36 turned out to be heifers and 29 steers. The success of this backcrossing approach aligns with findings from previous studies on the importance of preserving local breeds through genetic diversity. For instance, Rovelli et al. (2020) highlighted the significance of maintaining genetic variation within livestock populations to enhance their adaptability and resilience to local environmental conditions. Similarly, Martin et al. (2020) emphasized that genetic diversity is crucial for the development of sustainable agricultural production systems, as it provides a reservoir of traits that can be critical for future breeding programs and adaptation to changing climates.

Comparative characteristics of calf development obtained from Alatau and Brown Swiss bulls

Breed qualities are determined by their biological characteristics, which in turn depend on paratypic factors. At the same time, the development of babies- the level of feeding and maintenance largely determines beef, but different breeds kept under the same conditions can show varying results, depending on their specific breed qualities. Furthermore, authors highlighted that adaptive traits, such as disease resistance and metabolic efficiency, are crucial for the survival and productivity of livestock under various environmental conditions (Kabylbekova et al. 2024). These traits are often more pronounced in local breeds that have evolved over centuries to adapt to specific regions (Gnezdilova et al. 2023). For example, the Alatau breed, with its origins in the harsh climatic conditions of Kazakhstan, exhibits unique adaptive traits that contribute to its resilience and productivity under local conditions (Tables 3 and 4).

Table 3: Information on insemination of high-level bovine animals

A group of cows	Bloodline of cows according to the Brown Swiss breed	Number of cows in the group	Inseminated by bulls		Period of insemination (month/year)
			Nickname	Breed	
Information on insemination by Alatau bulls					
I	0,75	56	Dikar	Alatau	04/2019-08/2019
II	0.75	40	Sedoi	Alatau	04/2019-08/2019
Total	-	96	-	-	-
Information on insemination by Brown Swiss bulls					
III	0,75	40	Advisor	Brown Swiss	04/2019-12/2019
IV	0.75	53	Koos	Brown Swiss	2/2019-7/2019
Total	-	93	-	-	-

Table 4: Information on insemination of high-level bovine animals and resulting offspring

A group of cows	Bloodline of cows according to the Brown Swiss breed	Number of cows in the group	Inseminated by bulls		Period of insemination (month/year)	Fruitfully inseminated	Received calves		
			Nickname	Breed			total	Including	
								heifers	calves
Information on insemination by Alatau bulls									
I	0,75	56	Dikar	Alatau	04/2019-08/2019	37	39	20	19
II	0.75	40	Sedoi	Alatau	04/2019-08/2019	30	26	16	10
Total	-	96	-	-	-	67	65	36	29
Information on insemination by Brown Swiss bulls									
III	0,75	40	Advisor	Brown Swiss	04/2019-12/2019	35	30	15	15
IV	0.75	53	Koos	Brown Swiss	2/2019-7/2019	43	40	19	21
Total	-	93	-	-	-	78	70	34	36

Table 5: Growth and development of calves derived from thoroughbred Bulls of Alatau and Brown Swiss breeds

Bulls	Number of daughters	Live weight by month, kg				Average daily growth from birth to 18 months, gr
		At birth	6	12	18	
Daughters of Alatau bulls						
Dikar	11	30.6±0.4	172.2±8.3	300.1±15.3	382.1±16.7	640±30
Sedoy	12	28.5±0.6	134.3±5.1	224.4±7.6	346.4±7.7	579±15
Total/ average	23	29.5±0.4	152.4±6.2	260.6±11.4	363.5±9.51	608±15
Daughters of the Brown Swiss bulls						
Blessing	17	30.0±0.4	130.4±3.1	225.7±6.9	337.7±7.2	561±15
Koors	10	31.7±0.8	149.5±6.4	273.1±8.8	361.9±18.0	600±35
Total/ in average	27	30.6±0.4	137.5±3.5	243.3±7.0	346.7±8.2	576±15

To this end, the comparative characteristics of calf-daughter development obtained from bulls of Alatau and Brown Swiss breeds have been studied (Table 5).

The analysis of the data provided showed that, with a slight difference in live weight at birth, the daughters of the Alatau bulls in all periods of development were heavier than their peers received from Brown Swiss bulls. Thus, the difference in body weight at 6 months was 10.8% ($P \leq 0.95$), at 12 months – 7.1% ($P \leq 0.90$), and at 18 months – 4.8% ($P \leq 0.90$). In general, the average daily weight gain of heifers sired by Alatau bulls (from birth to 18 months) exceeded that of heifers sired by Brown Swiss bulls by 32 grams ($P \leq 0.90$), or 6.7%.

Analysis of the data in Fig. 1 shows that the development of heifers of Alatau bulls from birth to puberty lasts more intensively, and during puberty the growth rate tends to decrease, which is associated with a shift in the growth structure from predominantly muscular and skeletal to the accumulation of a certain amount of fat (Brody 1945).

At the same time, it is observed that the growth rate of the daughters of Brown Swiss bulls is stable in the range of 570-580g. for all periods. However, such a stable development of heifers negatively affects the economic situation of the farm, since heifers reach a certain live weight for the first insemination later, and consequently, the age of the first calving also increases. Additionally, Nasambaev et al. (2022) noted that reducing the age at first calving is crucial for improving the economic efficiency of dairy herds.

According to numerous studies (Van Eetvelde et al. 2020), it has been proven that a decrease in the age of the first calving is an environmental factor affecting milk yield and composition, has a positive effect on genetic progress, since the generation interval is shortened and the offspring of selective bulls is tested earlier (Pirlo et al. 2000). Reducing the age of the first calving can also reduce the cost of herd repairs, which is approximately 20% of total production costs (Heinrichs 1993). In addition, reducing the age of calving allows you to reduce feed costs and ensure an earlier return on investment (Gardner et al. 1988; Mourits et al. 1997; Pirlo 1997; Nilforooshan and Edriss 2004).

To study the age of the first calving of daughters received from Alatau and Brown Swiss bulls, the documents of primary zootechnical accounting were analyzed, the results of which are reflected in Table 6. The analysis of the presented data showed that the average age of heifers obtained from Alatau bulls at the first fruitful insemination bulls was 542 days or exactly 18.0 months, which was 52 days ($P \leq 0.99$) lower than that of the daughters of Brown Swiss bulls. At the same time, the age of the first calving of the daughters of the Alatau bulls was in the range of 26.7-28.3 months, and for the daughters of the Brown Swiss bulls it was 28.3-29.5 months, respectively. On average, the age of the first calving cows Alatau bulls was lower by 48 days ($P \leq 0.999$) or 1.6 months compared with the indicators of cows obtained from Brown Swiss bulls.

Table 6: Age of the first fruitful insemination of heifers obtained from Alatau and Brown Swiss bulls

Daughters of bulls	Number of daughters	Age of insemination of daughters, days		Age of first calving, days	
		M±m	Cv	M±m	Cv
Daughters of bulls of Alatau breed					
Dikar	11	517.3±22.2	13.7	803.9±23.4	9.2
Sedoy	12	566.0±23.9	14.0	846.9±23.8	9.3
Total/ average	23	542.7±17.0	14.7	826.3±16.9	9.6
Daughters of bulls of Brown Swiss breed					
Blessing	17	605.8±17.1	11.3	886.2±16.1	7.27
Koors	10	577.7±28.0	14.5	855.3±28.5	9.9
Total / average	27	595.4±14.9	12.8	874.8±14.6	8.51

Table 7: The level of milk productivity of the daughters of Alatau and Brown Swiss bulls

Bull name	n	Milk yield, kg		Fat (%)		Protein (%)	
		M±m	Cv	M±m	Cv	M±m	Cv
Daughters of the Alatau bulls							
Dikar	11	5565±151	13.0	3.99±0.09	11.1	3.34±0.05	6.7
Sedoy	12	4797±228	22.9	3.89±0.04	5.6	3.28±0.04	5.6
On average	23	5164±207	19.3	3.94±0.07	8.7	3.31±0.04	6.0
Daughters of the Brown Swiss bulls							
Blessing	17	5647±183	15.6	3.98±0.04	5.0	3.26±0.04	5.1
Koors	10	4573±175	18.4	4.33±0.17	19.1	3.32±0.10	14.6
On average	27	5249±208	19.0	4.11±0.11	13.1	3.28±0.07	9.6

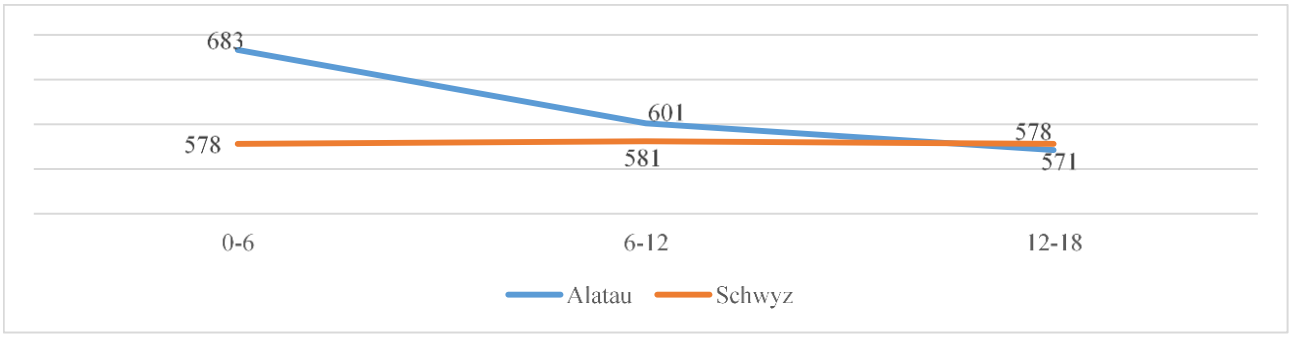

Fig. 1: Average daily live weight gains of heifers obtained from Alatau and Brown Swiss bulls by growth periods.

It follows that highly productive modern genotypes may not be as well developed as locally inefficient animals under conditions of stable grazing. Moreover, local breeds are less susceptible to udder diseases, metabolic disorders, good fertility, longer service life (Ingvartsen et al. 2003; Bytyqi et al. 2005; Gandini et al. 2007; Knaus 2009; Stiglbauer et al. 2013; Curone et al. 2016).

Dairy productivity

Low-cost milk production can be solved by extensive animal husbandry in general, and in this respect, local animal breeds adapted to the local feed resources and suitable for the specific production situation play a special role (Ten Napel et al. 2006; Colditz and Hine 2016; Berghof et al. 2019; van Hal et al. 2019).

For example, Bieber et al. (2019) indicated that local breeds from Sweden, Austria, Switzerland and Poland have a longer service life, have better health, and fertility, but produce less milk than Holstein and Brown Swiss rocks, which are used in intensive animal husbandry.

In our case, the milk yield of daughters of Alatau bulls was 85kg lower than that of the daughters of Brown Swiss bulls, however, no significant difference between the indicators was established (Table 7). The difference between the fat content of milk was 0.17% in favor of the daughters of the Brown Swiss breed, and the protein content was higher in the daughters of the Alatau bulls by 0.03%. In both cases, the difference is not true.

Conclusion

The results of the conducted research have shown the high importance of cryopreservation of genetic materials of farm animals and the possibility of reviving endangered breeds by backcrossing. The genetic characteristics of bulls undoubtedly play a role in the development of heifers and dairy productivity. However, in general, with almost the same milk production from one cow, locally adapted animals are more profitable in terms of reducing the first calving and obtaining earlier income from milk production compared with highly productive breeds. This fact indicates the profitability of milk production with limited feed resources and pasture cows. In the future, it is possible to study the genetic characteristics of the Alatau breed in order to identify the genes responsible for the adaptive properties of the breed, resistance to diseases, as well as at an early stage of ontogenesis to determine breeding qualities by the GBLAP method.

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Conflict of interest

The authors state that the research was conducted without any commercial or financial relationships that could be interpreted as a potential conflict of interest.

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Author's contribution

TK, AT: Designed and supervised the study; PS, ED: data collection and initial draft of the manuscript. All authors were involved in the data analysis and interpretation. All authors revised the article and confirmed the last version of the article.

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