ONLINE JOURNAL OF BIOLOGICAL SCIENCES

RESEARCH ARTICLE

Evaluation and Selection of Kushum Horses and their Dairy and Meat Productivity by Economic and Useful Traits

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Abstract: The research conducted a comprehensive evaluation of the Kushum horse breed based on economically valuable traits, including dairy and meat productivity, with the aim of selecting the most promising animals for further breeding. The research was conducted at two farms in Kazakhstan ("Bereke" and Kulunshak") in 2022-2025. 1084 individual horses were researched, including groups of horses of different intra-breed types. To study dairy productivity, 35 mares were used, and the meat productivity of 1.5- and 2.5-year-old foals was evaluated. It has been established that homogeneous selection of parents allows obtaining more productive offspring in terms of live weight, chest girth, and metacarpal girth. Stallions reached an average live weight of up to 620 kg, mares - up to 508 kg; the highest milk productivity was noted in mares of the basic type (up to 19.5 l/day); slaughter meat yield in 1.5-2.5-year-old foals reached 52.7-54.5%. Positive correlations were found between body measurements and live weight. The obtained results allow for increasing the effectiveness of Kushum breed selection in pasture maintenance, recommending predominantly homogeneous selection based on key productive traits.

Keywords: Live Weight, Selection, Productivity, Kushum Breed

Received: 15-03-2025 | **Revised:** 27-07-2025 | **Accepted:** 20-01-2026 | **DOI:** 10.3844/ojbsci.2026.26.02.039

Introduction

In Kazakhstan, particularly given the need for the efficient utilization of natural pastures unsuitable for other types of livestock, herd horse breeding - based on the biological adaptability of horses to year-round grazing - provides an economically viable and environmentally sustainable means of producing high-quality horse meat and mare's milk [1]. These products not only possess dietary and therapeutic properties but also play an important role in the national diet, thereby contributing to food security and the improvement of public health [2].

Among various breeds, the kushum horse occupies a special place due to its high live weight, adaptability to local conditions, and versatility for both meat and milk production. At the "Bereke" farm in the Zhambyl region and the "Kulunshak" farm in the Atyrau region, kushum horses are utilized, with their genetic potential for live weight reaching up to 711 kg in

stallions and 650 kg in mares [3]. To fully realize their productivity and economic potential, it is essential to continuously improve the breed through effective breeding and selection practices [1, 4].

To increase the productivity of the kushum breed, continuous improvement is necessary. Successful resolution of this problem depends on increasing the efficiency of breeding work, improving methods of selection, and identifying and realizing the genetic potential for productivity and breeding qualities of horses in production.

There are great opportunities for the future development of kushum horses both by increasing their numbers and improving their quality, as well as through the implementation of a number of organizational measures for more rational management of the industry [5].

The main objective of the research presented in the article is to evaluate and select kushum horses based on economically valuable traits, determine their meat and dairy productivity, as well as identify intra-breed differences and the influence of homogeneous and heterogeneous breeding methods.

Materials and Methods

Scientific and production experiments on the breeding and improvement of pedigree and productive traits of kushum horses were conducted in the Bereke peasant farms of the Zhambyl region and the Kulunshak peasant farm of the Atyrau region from May 2022 to January 2025, as shown in Figure 1 [6]. The map in Figure 1 highlights the geographical location of the studied farms within Kazakhstan, emphasizing the relevance of regional factors in the breeding program.

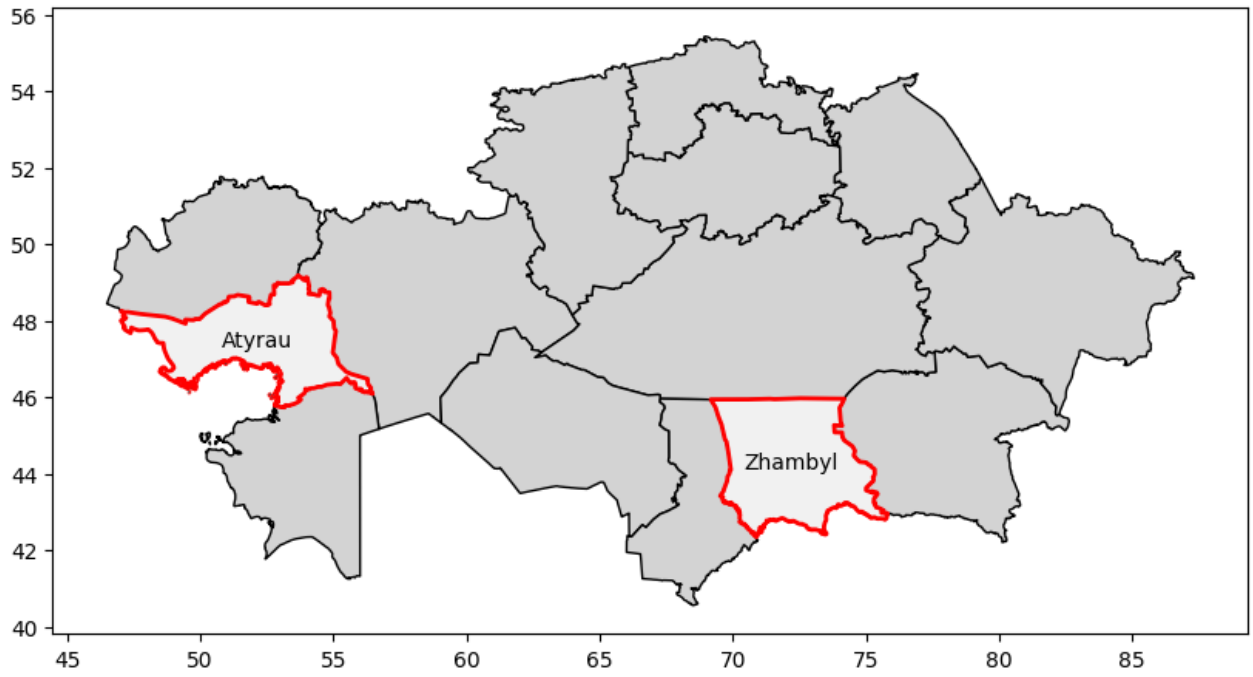

Fig. 1: Location of farms on the map of Kazakhstan

For the purpose of targeted breeding and selection work at the Bereke and Kulunshak farms, a total of 1,084 kushum horses were selected: 202 animals at the Bereke farm (192 mares and 10 stallions) and 882 animals at the Kulunshak farm (840 mares and 42 stallions). To study dairy productivity, 35 lactating mares aged 7 year of different inbred types were used: 15 animals at Bereke (7 basic, 5 massive, and 3 riding types) and 20 animals at Kulunshak (8 basic, 7 massive, and 5 riding types). Meat productivity was assessed in 18 colts aged 1.5 and 2.5 years (3 animals from each age group at each farm).

On both farms, breeding groups were formed exclusively from elite and first-class horses. Second-class animals were excluded from the breeding groups [7].

After the fall evaluation, in October 2022, horses were selected to form a breeding group. This group of animals corresponded to measurements and live weight, exterior, adaptability to herd conditions. Figure 2 illustrates the main linear measurements used in the study: height at withers, chest girth, torso oblique length, and metacarpal girth. These parameters are fundamental for characterizing the physical development and conformation of horses, as well as for monitoring the effectiveness of selection and breeding strategies. In the spring, only high-producing stallions of the elite class were selected for the chosen breeding group of mares. To consolidate the key selection traits of the kushum breed -broad body conformation and massive build, high adaptability to pasture and herd management, and increased live weight - a homogeneous selection method was applied, while heterogeneous selection was used to correct certain deficiencies identified during the evaluation process [8].

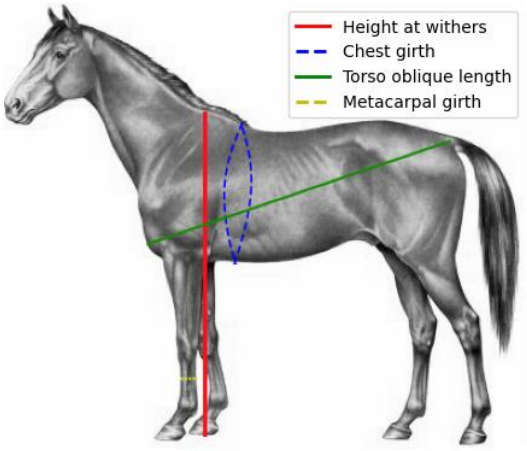

Fig. 2: Body measurements of horse

At the same time, the correlation between economically useful traits, the influence of paratic factors on the manifestation of genetically determined level of horse productivity in the phenotype was studied.

Kushum horses from both farms were kept year-round on natural pastures in the dry steppe zone without supplementary feeding. Watering was provided from artesian wells and natural water bodies. The pasture load was 20 hectares per horse.

Research on the milk yield of mares of different intra-breed types was conducted on three groups of mares in both farms over a 105-day lactation period in 2024.

Dairy productivity was calculated taking into account the milk sucked at night by the foal according to the formula of Saigin I.A. [4]:

$$Yc = \frac{Yd}{t} \times 24,$$

where, Yc - estimated amount of milk in 24 hours, kg; Yd - the actual amount of milk received per day, kg; t - the time period from the beginning to the end of milking mares during the day, hours; 24»- hours per day.

The meat productivity of kushum horses was evaluated by slaughtering 2.5-year-old colts at the slaughter facility of the farms according to the methodology of the All-Russian Research Institute of Horse Breeding (VNIIKonevodstva) in December 2024 and early January 2025 [9].

The chemical composition of meat serves as a key indicator of its nutritional value and quality, reflecting the levels of major nutrients such as moisture, fat, protein, and minerals (ash). These parameters vary depending on the animal's age, feeding regime, and physiological state.

Determination of Moisture Content

The moisture content in meat is determined by drying a weighed portion of finely ground sample in a drying oven at 103 ± 2 °C until a constant mass is achieved. This approach ensures high accuracy and reproducibility of results and is widely used in analytical practice for the standardization of food products [10].

Determination of Fat Content

Quantitative determination of fat in meat is performed by extraction with organic solvents, such as ether or hexane, followed by removal of the solvent and weighing of the fat residue. The most common method is the Soxhlet extraction, which provides efficient lipid extraction from muscle tissue and yields reliable results when analyzing various types of meat products [11].

Determination of Protein Content

The protein content is determined based on the total nitrogen content, measured by the Kjeldahl method. This method involves mineralization of the sample with concentrated sulfuric acid in the presence of a catalyst, subsequent release of ammonia, and its quantitative determination. The obtained values are recalculated to protein content using the appropriate conversion factor. The Kjeldahl method is recognized as the reference standard for protein analysis in foods of animal origin [12, 13].

Determination of Ash Content

Ash content is determined by incinerating a weighed portion of meat in a muffle furnace at 525-600 °C until a constant mass is reached. The residue after incineration corresponds to the mineral fraction of the product and reflects the total content of inorganic components in meat. This method is characterized by high accuracy and is used to assess the nutritional value and safety of meat products [10, 14].

Calculation of Energy Value

The energy value of meat is calculated based on the content of protein, fat, and carbohydrates using standard coefficients: 4 kcal/g for protein and carbohydrates, and 9 kcal/g for fat [15]. These calculations allow for an objective assessment of the nutritional value of meat products for different consumer groups [11].

Statistical data processing was performed using Microsoft Excel with the XLSTAT add-on (Addinsoft, Paris, France). The following statistical parameters were calculated: arithmetic mean ($\bar{X}$), standard deviation ($\pm m\bar{x}$), and coefficient of variation (Cv, %). The significance of differences between groups was assessed using Student's t-test, with statistical significance set at $p<0.05$. Pearson's correlation analysis was applied for correlation studies. Trait repeatability was determined using Plokhinsky's formula [16].

Results

An important link in pedigree work with the kushum breed of horses is the development of selection methods to improve pedigree and productive qualities under conditions of year-round pasture-grassland maintenance and purebred breeding [17].

The selection of mares for foals was aimed at establishing a broad build, massive physique, high adaptability to pasture-based maintenance, and the development of high live weight. To consolidate this desired trait, the best breeding stallions were paired with the best mares.

The results of applying homogeneous selection of horses with maximum expression of breeding traits and mating such breeding stallions with mares in which these traits are expressed to the lowest degree (heterogeneous selection) show that the studied traits in horses are better manifested in offspring from homogeneous selection of their parents than from heterogeneous selection. At the same time, depending on the prominence of the main traits, the productivity of the resulting offspring was highest in those animals in which the corresponding selection traits were dominant.

Table 1: Productivity of daughters at 30 months of age under different selection variants

Indicators	Homogeneous selection	Heterogeneous selection
Number heads	28	22
Height at withers, cm	151	148
Torso oblique length, cm	152	149
Chest girth, cm	170	164
Metacarpal girth, cm	19.5	18.5
Live weight, kg	438	402

Comparison of live weight and measurements of progeny from homogeneous and heterogeneous selection shows that the differences between them are not uniform. Thus, mares from homogeneous selection outperformed fillies from heterogeneous selection in live weight by 36 kg or 8.95%.

The linear measurements of progeny from homogeneous selection were superior to those from heterogeneous selection by 3.0 cm (2.02%) in height at the withers, 6 cm (3.66%) in chest girth, and 1.0 cm (5.41%) in metacarpal girth.

Thus, the studied variants of selection of kushum horses on the main economically useful traits show that more highly productive offspring are obtained through homogeneous selection of parents exhibiting maximal expression of breeding traits. In order to further improve the kushum breed of horses for more complete fixation in the offspring of breeding traits it is advisable to apply mainly homogeneous selection, focusing first on live weight, chest girth, and metacarpal girth.

In the process of directed breeding and pedigree work in both farms certain successes have been achieved. This can be judged by comparing the average data of adult kushum horses of both farms.

Table 2: Measurements and live weight of kushum horses

Farm	Indicators	Height at withers, cm	Torso oblique length, cm	Girth, cm		Live weight, kg
				chest	metacarpal	
Stallion breeders						
Bereke farm in Zhambyl region	n	10	10	10	10	10
	$\bar{x} \pm m\bar{x}$	159.4±0.61	161.9±0.69	194.6±0.77	20.9±0.19	604.3±3.6
	C_V	1.69	2.17	2.65	5.03	4.23
Kulunshak farm Atyrau region	n	42	42	42	42	42
	$\bar{x} \pm m\bar{x}$	159.9±0.65	162.5±0.66	196.2±0.71	21.5±0.18	619.7±3.2
	C_V	1.71	2.09	2.61	5.01	4.14
Mares						
Bereke farm in Zhambyl region	n	192	192	192	192	192
	$\bar{x} \pm m\bar{x}$	154.9±0.55	157.2±0.61	185.2±0.64	19.7±0.17	500.0±3.2
	C_V	5.09	5.88	5.01	10.47	7.5
Kulunshak farm Atyrau region	n	840	840	840	840	840
	$\bar{x} \pm m\bar{x}$	156±0.47	157.9±0.58	186.1±0.61	20.1±0.20	508.1±3.8
	C_V	4.71	5.76	5.05	10.22	6.9

As can be seen from the above data, “Kulunshak” mares exceed “Bereke” mares in height at the withers by 1.1 cm, oblique body length by 0.7 cm, chest girth by 0.9 cm, and live weight by 8.1 kg. The stallions produced by the “Kulunshak” farm were also larger. The differences are height at the withers by 0.5 cm, oblique body length by 0.6 cm, chest girth by 1.6 cm, and live weight by 15.3 kg.

Higher variability (Cv) was observed both in stallions (5.01-5.03) and mares (10.22-10.47) for metacarpal girth and in live weight (4.14-4.23 in stallions, 6.9-7.5 in mares), indicating these traits are effective targets for selection in further breeding work.

Kushum horses from both farms are homogeneous in their main characteristics. However, there are some differences in the physique of separate groups of horses, the size of their measurements, and their adaptation to pasture conditions. There are three types in the breed: basic, massive and riding [18].

Horses of the basic type are characterized by a pronounced massiveness of physique, strong constitution, well-developed musculature, and adaptability to year-round pasture keeping. Animals of this type well tolerate heat and cold. Mares are quite dairy. Mares have a withers height of 154-155 cm, oblique body length 156-157 cm, chest girth 184 cm, metacarpal girth 19.5-20.0 cm, live weight 492-496 kg.

Animals of the massive type, exhibiting excellent growth, have a long body, deep chest, and very high live weight. They have a very dense, rough constitution, pronounced meat forms, excellent adaptability to herd conditions and to the sharply

continental climate of steppes and semi-deserts, measurements and live weight of mares of massive type are 157-160-189-20.5 cm, 539 kg.

Table 3: Distribution of horses by inbreed types

Inbreed types	n	%	Height at withers, cm	Torso oblique length, cm	Chest girth, cm	Metacarpal girth, cm	Live weight, kg
Bereke farm stallion breeders							
Basic	5	50	159.4	162.3	195.1	21.0	605.7
Massive	3	30	160.3	163.2	198.3	21.5	651.3
Riding	2	20	158.2	159.0	188.0	20.0	530.5
Total	10	100	159.4	161.9	194.6	20.9	604.3
Kulunshak farm stallion breeders							
Basic	21	50	159.4	162.1	196.2	21.5	612.3
Massive	15	35	161.2	164.3	199.1	22.0	663.4
Riding	6	15	158.6	159.4	188.7	20.5	536.6
Total	42	100	159.9	162.5	196.2	21.5	619.7
Bereke farm mares							
Basic	86	44.8	154.1	156.2	184.3	19.5	492.6
Massive	61	31.8	157.2	159.8	188.2	20.5	530.2
Riding	45	23.4	153.2	155.6	182.8	19.0	473.4
Total	192	100	154.9	157.2	185.2	19.7	500.0
Kulunshak farm mares							
Basic	384	45.7	155.3	157.4	184.9	20.0	496.3
Massive	290	34.5	157.9	160.1	189.2	20.5	539.6
Riding	166	19.8	154.1	155.2	183.3	19.5	480.2
Total	840	100	156.0	157.9	186.1	20.1	508.1

Horses of the riding type are somewhat lighter in build compared to the basic and massive types, with a less developed body in both width and length. They have more pronounced features of thoroughbred and Don horses, have a developed gait, and are inferior to the first two types in terms of adaptability to herding. Average measurements and live weight of mares of the riding type are 154-155-183-19.5 cm, 480 kg. Horses of the riding type are used for work under saddle during cattle herding.

In further breeding work with the kushum breed, the distribution of farms into internal types has a certain importance. It greatly facilitates mass selection and selection, makes it possible to better organize the maintenance of herds and breeding of young stock.

High live weight and meat productivity of kushum horses are caused by the following main traits: height at the withers, oblique length of the body, chest and metacarpal girth, exterior, type and massiveness of the physique. These traits themselves have a complex character of inheritance and are in various interdependent relations both with the total trait of live weight and among themselves.

We have studied the correlation between the main measurements and live weight of horses.

As can be seen from Table 4, positive correlation is observed between all measurements and live weight in all sex and age groups, but the magnitude of these relationships is not uniform.

Chest girth and metacarpal girth have the highest correlation with live weight, followed by oblique torso length and height at the withers. Therefore, when selecting horses by live weight, we selected first of all by chest girth and metacarpal girth.

The age repeatability of live weight of horses was determined by comparing the body weight of young animals at early and later ages.

Table 4: Correlation coefficients between measurements and live weight

Gender and age groups	Height at withers live weight	Torso oblique length - live weight	Chest girth live weight	Metacarpal girth live weight
Bereke farm				
Stallions-breeders	0.132 ±0.184	0.215±0.181	0.318±0.171	0.345±0.168
Mares n=192	0.164±0.071	0.285±0.109	0.332±0.061	0.358±0.058
Colts 2.5 years old n=21	0.509±0.108	0.322±0.070	0.514±0.091	0.604±0.082
Fillies 2.5 years old n=60	0.497±0.116	0.352±0.059	0.568±0.082	0.672±0.079
Kulunshak farm				
Stallions-breeders n=42	0.148±0.098	0.243±0.175	0.365±0.162	0.366±0.154
Mares n=840	0.242±0.085	0.314±0.095	0.372±0.073	0.372±0.049
Colts 2.5 years old n=45	0.645±0.102	0.348±0.068	0.521±0.095	0.684±0.089
Fillies 2.5 years old n=120	0.501±0.109	0.391±0.048	0.573±0.078	0.701±0.081

Table 5: Age repeatability of measurements and live weight in kushum foals

Measurements (cm) and live weight (kg)	Indicator	Age of months				
		6	12	18	24	30
Bereke farm						
Withers height	$\bar{x} \pm m\bar{x}$	121.6±0.33	134.5±0.48	143.6±0.59	145.2±0.48	147.3±0.52
	Cv	1.52	1.70	1.72	1.80	2.03
	£	-	0.422	0.780	0.762	0.759
Oblique torso length	$\bar{x} \pm m\bar{x}$	119.4±0.38	132.3±0.41	141.3±0.62	140.6±0.51	147.2±0.49
	Cv	1.86	1.95	1.83	1.73	1.98
	£	-	0.485	0.778	0.735	0.763
Chest girth	$\bar{x} \pm m\bar{x}$	143.2±0.42	151.2±0.48	158.7±0.48	161.3±0.44	167.5±0.54
	Cv	1.87	1.75	1.68	1.76	1.83
	£	-	0.690	0.637	0.605	0.788
Metacarpal girth	$\bar{x} \pm m\bar{x}$	16.5±0.08	17.5±0.09	18.0±0.08	18.2±0.11	18.5±0.10
	Cv	2.88	3.18	2.74	3.54	3.04
	£	-	0.874	0.847	0.509	0.406
Live weight	$\bar{x} \pm m\bar{x}$	205.7±1.42	301.4±1.58	330.8 ± 1.76	355.2±2.17	422.4±2.53
	Cv	4.43	3.96	3.32	3.83	3.79
	£	-	0.886	0.853	0.832	0.861
Measurements (cm) and live weight (kg)	**Indicator**	**Age of months**				
		6	**12**	**18**	**24**	**30**
Kulunshak farm						
Withers height	$\bar{x} \pm m\bar{x}$	122.8±0.31	135.8±0.39	144.5±0.41	146.4±0.49	148.9±0.44
	Cv	1.17	1.43	1.34	1.18	0.95
	£	-	0.439	0.856	0.845	0.844
Oblique length torso	$\bar{x} \pm m\bar{x}$	120.2±0.37	133.1±0.58	142.2±0.41	142.1±0.37	148.6±0.32
	Cv	1.45	2.19	1.39	1.18	0.91
	£	-	0.534	0.829	0.725	0.780
Chest girth	$\bar{x} \pm m\bar{x}$	144.5±0.51	152.3±0.56	159.8±0.53	163.4±0.62	169.2±0.68
	Cv	1.72	1.60	1.44	1.63	1.69

	£	-	0.780	0.705	0.737	0.839
	$\bar{x} \pm m\bar{x}$	16.7±0.10	17.5±0.09	18.5±0.08	19.3±0.10	19.1±0.11
Metacarpal girth	Cv	2.72	2.36	1.98	2.42	2.53
	£	-	0.960	0.932	0.670	0.526
	$\bar{x} \pm m\bar{x}$	212.3±1.49	315.8±1.59	341.4±1.92	362.4±2.27	436.2±2.74
Live weight	Cv	2.91	3.21	2.25	2.50	2.53
	£	-	0.982	0.944	0.862	0.901

When studying the dynamics of productivity of kushum horses depending on age, it was found that the horses of Kulunshak farm are somewhat larger, exhibiting a tendency toward higher live weight and chest girth measurements compared to the young stock of the “Bereke” farm.

In general, there is a high positive relationship between measurements and live weight of animals at 6 months of age and at older age in both farms.

Scientific and economic experiments on the study of dairy productivity of kushum mares of different inbred types were conducted on a seasonal koumiss farm of the peasant farm Bereke of Zhambyl region and peasant farm Kulunshak of Atyrau region on 3 groups of mares of different inbred types. Measurements and live weight of dairy mares are given in Table 6.

Table 6: Measurements and live weight of dairy mares

Inbreed types	n	Measurements, cm				Live weight, kg
		Withers height	Oblique torso length	Girth		
				chest	metacarpal	
Bereke farm						
Basic	7	152.6±0.54	154.5±0.56	182.8±0.67	19.2±0.11	479.4±2.45
Massive	5	156.6±0.48	159.4±0.51	187.4±0.59	20.3±0.10	519.8±2.31
Riding	3	154.0	155.1	181.0	19.0	469.6
Kulunshak farm						
Basic	7	153.4±0.41	155.6±0.49	183.1±0.57	19.5±0.12	488.7±2.57
Massive	5	157.1±0.39	160.2±0.46	187.8±0.52	20.5±0.11	531.6±2.48
Riding	3	154.6	155.8	181.3	19.0	470.2

The data presented in Table 6 show that the experimental mares are typical representatives of their respective intra-breed types. The massive type of mares differs from the other types by its broad body conformation, with chest girth reaching 187.4-187.8 cm, substantial bone structure, with metacarpal girth measuring 20.3-20.5 cm, and high live weight ranging from 519.8 to 531.6 kg.

Mares on both farms were milked three times daily, with intervals of 2.5 hours between sessions. Milking mares more than three times per day negatively affects foal growth; therefore, milking was limited to three times per day.

Commercial milk yield of mares was determined monthly for 105 days of lactation, twice a month on two contiguous days during the period 2024.

Our studies showed that mares of different inbred types had unequal milk production. Mares of the basic type had higher dairy production at pasture keeping. Then, in descending order, there are mares of massive type, and finally, mares of top type.

Table 7 shows that the average daily milk yield in the second month of lactation was in mares of basic type (17.28-16.64 l), followed by animals of the massive type (15.36-14.40 l). In mares of the top type these indicators were respectively 12.80 and 12.48 liters. In the last months of lactation, the lowest average daily milk yields were in all groups of mares: in main type animals 3.5 - 3.2 liters, in massive type animals 3.0-2.8 liters and in top type animals 2.6-2.2 liters.

The milk yield of the mares throughout lactation varied considerably. Mares showed higher productivity during the 2nd to 3rd months of lactation, after which milk yield gradually decreased, with a sharper decline toward the end of lactation.

Meat productivity of kushum horses was established by slaughtering stallions of different ages at the slaughterhouse of farms.

Slaughtering of horses in the farm Bereke was carried out in late December 2024 and in the farm Kulunshak in early January 2025.

Table 7: Dairy productivity of kushum mares of different inbred types (I)

Inbreed types	n	Milk yield	One month of lactation			
			May II	June	July	August
Bereke farm						
Basic	7	In 24 hours.	17.28±0.73	19.52±0.61	14.72±0.65	11.20±0.64
		For the month.	535.7±22.9	585.6±19.4	456.3±20.3	145.6±19.8
Massive	5	In 24 hours.	15.36±0.89	16.64±0.96	13.12±0.63	9.60±0.65
		For the month.	476.2±25.7	499.2±28.8	406.7±25.8	124.8±26.6
Riding	3	In 24 hours.	12.80	13.76	11.20	8.32
		For the month.	396.8	412.80	347.20	108.16
Kulunshak farm						
Basic	8	In 24 hours.	16.64±0.68	13.44±0.61	13.44±0.61	9.92±0.64
		For the month.	515.8±21.3	416.6±18.9	416.6±18.9	128.9±20.1
Massive	7	In 24 hours.	14.40±0.72	12.48±0.91	12.48±0.91	8.96±0.82
		For the month.	444.6±26.6	386.9±28.4	386.9±28.4	116.5±27.1
Riding	5	In 24 hours.	12.48±0.48	10.56±0.64	10.56±0.64	7.04±0.49
		For the month.	386.9±14.7	327.4±20.1	327.4±20.1	91.5±14.6

Table 8: Slaughter indicators of kushum colts (n = 3 heads each)

Age and sex groups of horses	Pre-slaughter live weight, kg	Carcass weight, kg	Slaughter yield %
Bereke farm			
Colts 1.5 years old	365.7	198.2	54.2
Colts 2.5 years old	426.3	224.7	52.7
Kulunshak farm			
Colts 1.5 years old	376.0	204.9	54.5
Colts 2.5 years old	438.3	232.3	53.0

In terms of carcass weight, 1.5-year-old colts were 26.5 - 27.4 kg (11.8%) behind 2.5-year-old colts. The slaughter yield of 2.5-year-old colts was 1.5% lower than that of 1.5-year-old young stock.

Colts aged 1.5 and 2.5 years from the “Kulunshak” farm slightly exceeded the young stock from the “Bereke” farm in live weight and carcass weight. This difference is attributed to the results of purposeful selection and breeding work. Thus, the “Kulunshak” farm has been conducting breeding work to improve the pedigree and productive qualities of the Kushum breed of horses since 2010, while the “Bereke” farm began these activities only in 2022.

Currently, the increasing demand for high-quality horse meat by the population necessitates obtaining carcasses with high meat yield, even distribution of fat between and within muscles, a thick layer of abdominal fat suitable for making kazy, and relatively low specific bone weight.

The data in Table 9 show that the absolute weight of all cuts was higher in 2.5-year-old colts compared to 1.5-year-old youngstock.

Thus, carcasses of 1.5-year-old colts were inferior to 2.5-year-old colts by 5.1-6.8 kg (2.3-2.9%) in the weight of the kazy cut, by 9.3-8.8 kg (4.1-3.8%) in the weight of the rear part, and by 26.5-27.4 kg (11.8%) in the weight of the carcass as a whole, 1.5-year-old colts were inferior to 2.5-year-old colts.

Table 9: Weight ratio of different carcass parts by grades

Carcass cuts by grade		Farm									
		Bereke farm					Kulunshak farm				
		In carcass kg	flesh		bones		In carcass, kg	flesh		bones	
			kg	%	kg	%		kg	%	kg	%
Colts 1.5 years old											
Off-grade	Zhal	2.6	2.6	1.3	-	-	3.0	3.0	1.5	-	-
	Kazy	25.7	23.3	11.7	2.4	1.2	26.1	23.6	11.5	2.5	1.2
I grade	Dorsal part	11.8	7.7	3.9	4.1	2.1	12.9	8.6	4.2	4.3	2.1
	Rear part	70.5	61.0	30.8	9.5	4.8	72.7	62.5	30.5	10.2	5.0
II grade	Shoulder-scapular region	65.9	55.5	28.0	10.4	5.2	67.1	56.1	27.4	11.0	5.4
	Femural part	7.4	3.9	2.0	3.5	1.8	7.8	4.2	2.0	3.6	1.8
III grade	Chuck	2.5	1.5	0.7	1.0	0.5	2.6	1.5	0.7	1.1	0.5
	Shank	6.8	3.0	1.5	3.8	1.9	7.5	3.4	1.7	4.1	2.0
	Hock	5.0	0.9	0.5	4.1	2.1	5.2	1.0	0.5	4.2	2.0
Total		**198.2**	**159.4**	**80.4**	**38.8**	**19.6**	**204.9**	**163.9**	**80.0**	**41.0**	**20.0**
Colts 2.5 years old											
Off-grade	Zhal	4.2	4.2	1.9	-	-	4.6	4.6	2.0	-	-
	Kazy	30.8	28.2	12.5	2.6	1.2	32.9	30.2	13.0	2.7	1.2
I grade	Dorsal part	15.6	10.7	4.8	4.9	2.2	15.8	10.8	4.7	5.0	2.1
	Rear part	79.8	67.6	30.1	12.2	5.4	81.5	69.0	29.7	12.5	5.4
II grade	Shoulder-scapular region	70.2	57.1	25.4	13.1	5.8	72.7	59.1	25.4	13.6	5.9
	Femural part	8.1	4.4	1.9	3.7	1.6	8.3	4.3	1.9	4.0	1.7
III grade	Chuck	2.7	1.6	0.7	1.1	0.5	2.9	1.9	0.8	1.0	0.4
	Shank	7.8	3.8	1.7	4.0	1.8	7.9	3.6	1.5	4.3	1.9
	Hock	5.5	1.3	0.6	4.2	1.9	5.7	1.0	0.4	4.7	2.0
Total		**224.7**	**178.9**	**79.6**	**45.8**	**20.4**	**232.3**	**184.5**	**79.4**	**47.8**	**20.6**

However, the carcasses of 1.5-year-old colts exceeded those of 2.5-year-old colts by 0.6-0.8% in slaughter yield, and the bone content in carcasses was higher in 2.5-year-old animals by 6.8-7.0 kg. For every 1 kg of bones, there were 4.0-4.1 kg of flesh in 1.5-year-old colts and 3.8-3.9 kg in 2.5-year-old colts.

The chemical composition of meat is one of the important indicators reflecting its nutritional value. This composition does not remain constant during the individual development of animals and is closely related to the level of feeding and management, age, and body condition.

Chemical analysis of meat from 2.5-year-old colts showed the following contents: moisture - 58.7%, fat - 21.8%, protein - 18.4%, ash - 1.1%. The energy value of 1 kg of meat was 11.656 kJ. For 1.5-year-old colts, the contents were: moisture - 65.5%, fat - 13.4%, protein - 20.2%, ash - 0.9%, with an energy value of 9.621 kJ.

Thus, when producing fattier and higher calorie meat, 2.5-year-old young stock should be slaughtered, and when producing a dietary, easily digestible product, 1.5-year-old colts should be slaughtered.

Discussion

Contribution of the Study to the Improvement of Protocols for the Selection of Kushum Horses

The results of this study make a significant contribution to the revision and improvement of selection and breeding protocols in the production system of the kushum horse breed in Kazakhstan. For the first time, a comprehensive evaluation of the effectiveness of various selection methods (homogeneous and heterogeneous) was conducted under the conditions of the Bereke and Kulunshak farms, with a focus on key economically valuable traits: live weight, chest and metacarpal bone girth, as well as morphological and productive characteristics according to the breed's internal types. It was demonstrated that the use of homogeneous selection based on pronounced breeding traits (particularly live weight, chest and metacarpal bone girth) ensures the production of more productive offspring compared to heterogeneous selection. This is supported by high repeatability coefficients (0.778-0.944), which allows for the recommendation to revise existing protocols and to place greater emphasis on early selection for these traits, starting from six months of age. Such an approach promotes faster fixation of desirable qualities within the population and can be implemented in the practice of other farms engaged in kushum horse breeding [1, 19]. Unlike heterogeneous and outbreeding crossbreeding aimed at expanding genetic diversity and renewing the gene pool through the combination of individuals with differing phenotypes, homogeneous selection ensures standardization and stable inheritance of breed type. Modern index-based and genomic selection methods allow for comprehensive improvement of a set of economically valuable traits, but require significant informational and technical resources [20, 21].

Effect on Horse Productivity, Pasture Quality, Water Availability and Climate

Although the provided studies did not directly examine the impact of pasture quality on productivity, it is noted that vegetation, climate, and animal density in the pasture play an important role in maintaining the health of horses and the ecosystem as a whole. These factors can indirectly influence productivity through the availability of nutrients and water [22]. Extreme climatic conditions, especially high temperature and humidity, significantly reduce the horse's performance [23]. However, the kushum horse breed combines high productivity with pronounced adaptive qualities, which enables it to effectively survive and be utilized under conditions of year-round pasture-based management [24].

Correlation of the Obtained Results With Previous Research

The obtained data are consistent with the findings of several previous studies. In particular, research by Rzabayev et al. [24] and other authors has demonstrated that line breeding and targeted selection for economically important traits (live weight, morphometric indicators) can significantly enhance the productivity of kushum horses, as well as facilitate the development of new intra-breed types with high meat and milk productivity [24]. Purposeful selection based on morphometric traits and the use of highly productive breeding stallions lead to improvements in the meat and dairy qualities of the breed.

Nguyen et al. [5], in their genetic analysis of the kushum breed, emphasize the importance of considering genetic diversity and the inheritance patterns of key traits when forming selection groups. Our results confirm that the differences among the internal types (basic, massive, and riding) are not only morphological but also productive: mares of the basic type exhibit the highest milk yield, those of the massive type show superior meat productivity, while the riding type demonstrates versatility of use. These findings are fully consistent with data on intra-breed differentiation.

Moreover, this study corroborates the findings of other authors regarding the high adaptability of the kushum breed to year-round herd management conditions and its potential for the sustainable development of meat and dairy horse breeding in Kazakhstan. kushum horses are not inferior to, and in several respects surpass, other domestic breeds in terms of young stock survival, meatiness, and milk productivity [25].

Genomic Selection in Beef Breeds

American breeds (Quarter Horse, Paint) demonstrate the effectiveness of selection for genes associated with muscle mass and growth rate. Studies have revealed the key role of mutations in the MSTN (myostatin) gene, which are actively utilized to improve meat quality [26, 27].

In European countries (Sweden, Germany, France), comprehensive systems for breeding value assessment and genetic correlation analysis between traits are being implemented, which makes it possible to accelerate breed improvement for target characteristics [28].

Comparative studies of local breeds from Russia and Central Asia (Tuvan, Kyrgyz, Mugalzhar) have revealed the presence of unique alleles and a high level of genetic diversity, which contributes to adaptability and the stability of productive traits under extreme conditions [29]. Meat-and-dairy breeds such as the Mugalzhar and Bashkir are characterized by high levels of meat and milk productivity, as well as resilience to pasture-based management, which confirms the effectiveness of comprehensive breeding programs similar to those applied to the kushum breed [30].

The use of homogeneous selection for key traits can be recommended for inclusion in the selection and breeding system of kushum horses to enhance productivity and economic efficiency, as well as for the development and preservation of the gene pool.

Conclusion

As a result of the extensive use of highly productive kushum breed stallion-producers in the farms of “Bereke” and “Kulunshak”, breeding groups have been created that reliably transmit their traits to the offspring.

By applying the method of homogeneous and heterogeneous selection and selection, horses with high productive qualities and breeding merits were obtained.

The positive correlations between live weight and height at the withers (0.132-0.148), live weight and oblique trunk length (0.215-0.243), live weight and chest girth (0.317-0.365), live weight and metacarpal girth (0.345-0.366), established in kushum horses, indicate the possibility of selection on the mentioned sectionalized traits, but first of all it is necessary to select on metacarpal girth and chest girth.

It is established that in kushum horses age repeatability of live weight and 4 main measurements at the age from 6 to 12, from 6 to 18 and from 6 to 30 months have high indicators, which are in the range from 0.778 to 0.944, which gives a real opportunity to conduct preliminary selection from 6 and 18 months.

Under the conditions of the seasonal koumiss farms of the peasant farms “Bereke” and “Kulunshak”, the milk yield of Kushum mares of different inbred types is not identical. The most productive are mares of the basic type (535.7-515.8 liters), followed by those of the massive type (476.2-444.6 liters), and finally the riding type (396.8-386.9 liters).

Meat productivity of kushum horses was characterized by higher values in 2.5-year-old colts in comparison with 1.5-year-old animals. Slaughter yield of 1,5-year-old colts was 54.2-54.5%, of 2,5-year-olds - 52.7-53.0%, by carcass weight 2,5-year-old colts surpassed 1,5-year-olds by 26.5-27.4 kg (12.9-11.8).

The morphological composition of carcasses of kushum horses of different ages was not the same. Flesh yield in carcasses of 2.5-year-old colts was higher by 19.5-20.6 kg (12.2-11.2%) compared to 1.5-year-old animals, and relative bone content in carcasses of 1.5-year-old colts was lower than in 2.5-year-old colts. Per 1 kg of bones, 4.1-4.0 kg of flesh was obtained in 1.5-year-old colts, and in 2.5-year-old colts - 3.9-3.8 kg.

Acknowledgment

The authors would like to express their sincere gratitude to the peasant farm Bereke in Zhambyl region and the peasant farm Kulunshak in Atyrau region for providing the research facilities and livestock necessary for conducting scientific and economic experiments on the breeding and improvement of pedigree and productive qualities of kushum horses.

Funding Information

This research was supported by the project BR22887106 Application of molecular genetic methods for optimizing the management of horse genetic resources and the development of innovative technologies for productive horse breeding.

Author's Contributions

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Iskhan Kairat: Supervision, funding acquisition, critical revision of the manuscript.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues are involved.

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