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Growth Dynamics and Meat Productivity of the Kushum Horse Breed

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Abstract: In the conditions of the south-eastern zone of the Almaty region under herd management conditions without altering the existing husbandry practices the meat productivity of Kushum breed of horses is increased in the Bayserke Agro Farm due to breeding of highly productive stallions and mares of the Kushum breed. The primary objective of this study is to assess the productivity, growth patterns, and morphological quality of meat from Kushum breed horses within the framework of Bayserke Agro LLP Farm located in the Almaty region. The population of Kushum stallions and mares differs from local Kazakh horses in having better meat conformation and higher live weight. In terms of live weight, Kushum breed stallions exceed the standard of the first class by 42.6 kg (8.52%) and mares respectively by 12.5 kg (2.66%). The Kushum horses at the farm exhibit well-developed meat conformation, rapid growth, and a large chest circumference. With high live weight and perfect meat conformation, we analysed body weight gain in the spring and autumn periods. During fattening the young stock of the Kushum breed, which came out of the summer heat in the state of lower-middle fatness, reached the highest condition. Studies have shown that for the first 20 days of autumn fattening the average daily gain of stallions reaches 805-725 g per day. Then on the 40th day of fattening the average daily gain decreases and reaches 510-260 g, and at the end of fattening on the 60th day of fattening 80-70 g. When slaughtering foals after fall fattening, carcasses with high slaughter yield (53.3-51.6%), high flesh content (80.2-82.5%) and relatively low bone content (17.5-19.8%) were obtained.

Keywords: Kushum Horses, Meat Productivity, Growth Dynamics, Breeding Efficiency, Fattening Strategies

Introduction

Productive horse breeding represents a promising and highly effective sector within Kazakhstan's animal husbandry (Sansyzbayev et al., 2024). In terms of meat productivity, horses are competitive with specialized cattle breeds, achieving a slaughter yield of 51-58% and a meat-to-carcass yield of up to 82% (Akimbekov et al., 2019). The resulting meat is a valuable dietary product, distinguished by its high nutritional value, complete profile of essential amino acids, and a favorable composition of biologically valuable fats (Kargaeyeva et al., 2019).

The potential for this multipurpose industry is strengthened by Kazakhstan's natural advantages. All regions offer extensive natural fodder lands, enabling grazing and pasture-based maintenance (Iskhan et al., 2024). Furthermore, the seasonal zhailau (summer pastures) provide an optimal environment with abundant forage, reliable water sources, and a notable absence of blood-sucking insects, which collectively support efficient production and contribute to favorable production costs (Nurmakhanbetov et al., 2022).

The Kushum breed plays an exceptionally important role in the qualitative transformation of herd horse breeding in Kazakhstan, primarily as a source of meat and dairy products (Orazymbetova et al., 2023). A key asset of the Kushum horse is its pronounced adaptability to local environmental conditions (Nguyen et al., 2020). This breed exhibits high resilience to temperature extremes, efficient recovery when management improves, and a strong capacity to accumulate fat

reserves, particularly in autumn. Under the favorable conditions of spring and autumn pastures, Kushum horses demonstrate accelerated growth. Furthermore, the mares are noted for high milk yield, ensuring the robust development of their foals (Rzabayev et al., 2022).

The breeding of Kushum horses at the Bayserke Agro farm focuses on utilizing purebred lines and high-productivity animals to produce cost-effective and environmentally sustainable meat and koumiss (Zhaleluly, 2020). To achieve this, the farm employs purebred breeding as its primary method. The core objective of this approach is to preserve and enhance the breed's defining qualities. Its biological foundation lies in consolidating the heredity and productivity of the Kushum stock.

This research aims to evaluate the productivity, growth dynamics, and meat quality of Kushum horses under the farm's conditions. Specifically, the study focuses on selection efficiency, live weight gain across feeding periods, nutrient digestibility, and meat yield at different ages. By analyzing these parameters, we seek to optimize breeding strategies and feeding practices to enhance the economic efficiency of horse meat production.

Materials and Methods

A scientific and economic experiment to improve the pedigree and productive qualities of Kushum horses was conducted from 2021 to 2022. The study took place at the Bayserke Agro LLP Farm in the Talgar District of Kazakhstan's Almaty Region. This mountainous area exhibits considerable climatic diversity: the northern slopes of the Zailiyskiy Alatau range experience a warmer, more humid climate, while the Lepsinskiy basin is colder. The regional frost-free period lasts 100 to 170 days, with annual precipitation of 600-620 mm, peaking during the summer months.

For breeding, a selected group of mares (n=160) was paired exclusively with high-productivity, elite-class stallions (n=10). We employed a dual selection strategy: homogeneous selection to fix desirable economic traits, and heterogeneous selection to correct specific conformational deficiencies. These deficiencies were identified through four standard body measurements: withers height, oblique body length, chest circumference, and metacarpal girth. All measurements and subsequent horse classification were performed according to the official protocol established by the Ministry of Agriculture of the Republic of Kazakhstan (2023). Using these measurements and live weight, we calculated key physique indices, format, girth, boniness, and massiveness, as defined by Urbanek & Zebeli (2023).

The growth and development of foals were studied from three days to 30 months of age, from May 2020 to October 2022. Body measurements and weights were used to determine the physique indices of the young horses.

Feeding regimes consisted of spring-summer and autumn pasturing (15 April 2021 - 23 June 2021 and 2 October 2021 - 1 December 2021) on the farm's natural pastures, followed by a winter fattening period (15 December 2021 - 9 February 2022) using farm-produced fodder. The duration of each pasturing and fattening phase was adjusted based on the horses' body condition.

Before each phase began, foals were individually weighed on a one-ton scale, and body condition was scored according to the GOST 20079-74 standard. Subsequent weighings were performed every ten days.

During pasturing, horses grazed freely. The fattening phase employed hay-concentrate rations formulated per the average live weight of groups and based on established feeding norms for working horses (Kargaeyeva et al., 2023). The nutritive value of the diets was calculated from the chemical composition of the forages. Feed intake was determined by weighing offered feed and leftovers every ten days.

The digestibility of the hay-concentrate diets was assessed using the method recommended by Akimbekov & Baimukanov (2017). For the trial, three animals were selected from each experimental group. Throughout the digestibility study, these stallions were housed in individual pens.

The experiment followed a standard protocol consisting of a 12-day preliminary adaptation period, followed by an 8-day formal collection period. In both phases, the young horses (18 and 30 months of age) were fed rations formulated according to their live weight. Daily individual records were maintained for all feed offered and any refusals.

Chemical analyses of the feed and uneaten residues were performed in the Laboratory of Feeding Norms for Agricultural Animals at KazNARU, following established methodologies (Carvalho et al., 2021).

The digestibility coefficients of nutrients in the foals' fattening diets were calculated based on recorded feed intake and the chemical analysis of offered forages and their uneaten residues (Alferov et al., 2022).

To study the morphological composition of meat from the experimental stallions, a control slaughter was conducted at the Bayserke Agro LLP abattoir. The procedure followed the methodology of the All-Russian Research Institute of Horse Breeding (Kargaeyeva et al., 2023) and adhered to standard technological instructions for the meat industry.

Carcass quality was assessed visually for muscle tissue development, external fat coverage, and the thickness of fat on the abdominal wall. Additionally, quantitative analyses were performed to determine the

flesh-to-bone ratio in the carcasses and individual cuts, as well as the proportional yield of individual cuts from the carcass.

Each cut from a horse carcass serves a distinct purpose in traditional product preparation. The fatty neck ridge (from the first thoracic vertebrae) is used for zhal (under-the-mane fat). The posterior rib part is for kazy sausage, while the upper, fatty muscle tissue from the hip becomes zhaya. The loin yields sur-et (cured meat). Finally, the remaining muscular and fatty parts are used for sausage products, such as chuzhuk (Makhatov et al., 2023).

Experimental data were processed using standard biometric methods (Iskhan et al., 2019; Steinfath et al., 2018) with Microsoft Excel and its Data Analysis ToolPak. Differences between the two breeds were assessed for significance using Student's t-test.

Results and Discussion

The classification of the breeding stock is presented in Table 1. Among mares, 30% were elite, 50% first class, and 20% second class. A similar distribution was observed in the 1.5- and 2.5-year-old young stock (n=220), with 31.8% elite, 44.6% first class, and 23.6% second class.

Morphometric measurements of adult Kushum breed stallions and mares are compared to those of Kazakh horses of the Zhabe type in Table 2.

Table 1: Quantity and class composition of horses of the Kushum breed

Gender and Age Groups	Total	Class		
		Elite	I	II
Stallions	10	10	-	-
Mares	160	48	80	32
Colt 2.5 year	25	7	12	6
Filly 2.5 year	76	27	30	19
Colt 1.5 year	52	16	22	14
Filly 1.5 year	67	20	34	13
Total	390	128	178	84

Table 2 shows that Kushum stallions significantly exceed their Kazakh Zhabe counterparts across all measured traits. The differences are as follows: withers height (+13.2 cm), oblique body length (+9.7 cm), chest girth (+5.2 cm), metacarpal girth (+1.5 cm), and live weight (+71.2 kg). All differences were highly statistically significant ($p < 0.01$ to $p < 0.001$), with t-statistics ranging from 4.5 to 19.1.

A similar trend was observed in mares. Kushum mares surpassed Zhabe mares in withers height (+10.1 cm), oblique body length (+8.7 cm), chest girth (+5.2 cm), metacarpal girth (+0.8 cm), and live weight (+35.4 kg). These differences were also highly significant ($p < 0.01$ to $p < 0.001$), with t-statistics ranging from 4.2 to 15.8.

Table 2: Measurements and live weight of horses of the Kushum Breed and Kazakh Zhabe type horses

Indicators	Stallions				Mares			
	Kushum (n=10)		Zhabe (n=21)		Kushum (n=160)		Zhabe (n=375)	
	Mean ± SEM	t-statistic	Mean ± SEM	t-statistic	Mean ± SEM	t-statistic	Mean ± SEM	t-statistic
Height at withers (cm)	158.4±0.69	19.1	145.2±0.49	13.2	153.2±0.51	15.8	143.1±0.39	10.1
Body length, oblique (cm)	161.2±0.74	9.9	151.5±0.64	9.7	158.0±0.63	11.0	149.3±0.48	8.7
Chest girth (cm)	189.5±0.88	4.5	184.3±0.75	5.2	185.4±0.71	6.34	180.2±0.42	5.2
Metacarpal girth (cm)	21.0±0.12	6.8	19.5±0.19	4.5	19.3±0.09	4.2	18.5±0.17	0.8
Live weight (kg)	542.6±4.72	15.2	471.4±2.60	71.2	482.5±3.69	6.68	447.1±3.80	35.4

SEM: Standard Error of the Mean

Table 3: Measurements and live weight of colts and fillies

Gender and Age	Number	Live weight (kg)	Withers height (cm)	Body length, oblique (cm)	Chest circumference (cm)	Metacarpal girth (cm)
Colt 1.5 year	52	146.5±0.61	144.2±0.66	163.3±0.71	16.1±0.11	360.7±4.2
Colt 2.5 year	25	151.6±0.57	149.3±0.62	174.4±0.68	18.6±0.09	440.8±3.7
Filly 1.5 year	67	144.2±0.56	143.1±0.63	161.6±0.68	15.2±0.10	332.4±3.9
Filly 2.5 year	76	148.8±0.49	147.5±0.58	171.6±0.62	17.5±0.08	408.1±3.2

The average body measurements and live weight of the 1.5- and 2.5-year-old young stock meet the standards for the elite and first classes. This indicates robust growth and development from an early age, even under winter pasture conditions (Table 3).

A detailed comparison to mature adult benchmarks reveals a clear growth trajectory. As shown in Table 3, 2.5-year-old colts achieve the following percentages relative to adult stallions: 97.2% for withers height, 92.6% for oblique body length, 92.0% for chest girth, 88.6% for metacarpal girth, and 81.2% for live weight. At 1.5 years old, colts reach 92.5%, 89.5%, 86.2%, and 76.7% of the same measurements, respectively, and 66.5% of adult live weight.

A similar progressive development is seen in fillies. By 2.5 years, they attain 97.1% of mature mare height, 93.3% of body length, 92.6% of chest girth, 90.7% of metacarpal girth, and 84.6% of live weight. At 1.5 years,

the corresponding percentages are 94.1%, 90.6%, 87.2%, 78.8%, and 68.9%.

This consistent pattern demonstrates that the young stock are following an optimal growth curve, effectively translating nutritional inputs into skeletal and muscular development as expected for the breed.

At the Bayserke Agro farm, a comparison of two selection methods showed that offspring from homogeneous selection, mating parents both expressing strong breeding traits, exhibited superior trait expression compared to offspring from heterogeneous selection, where highly productive stallions were mated with mares showing minimal trait expression (Table 4).

As shown in Table 4, 2.5-year-old fillies from homogeneous selection surpassed their heterogeneously selected peers in all linear body measurements: withers height by 0.6 cm (0.4%), oblique body length by 1.7 cm (1.2%), chest girth by 2.3 cm (1.3%), metacarpal girth by 0.5 cm (2.8%), and live weight by 26.3 kg (6.6%). These results demonstrate that homogeneous selection of parents with maximally expressed breeding traits yields more productive offspring.

Table 4: Measurements and live weight of 2.5 year old fillies under different selection options

Indicators	Selection Options	
	Homogeneous	Heterogeneous
Number	14	16
Height at withers (cm)	149.2	148.6
Body length, oblique (cm)	147.9	146.2
Chest circumference (cm)	173.1	170.8
Metacarpal girth (cm)	18.0	17.5
Live weight (kg)	422.5	396.2

A critical component of selection and pedigree work for improving the Kushum breed is establishing standardized growth references for foals. To this end, we conducted a study to characterize the growth and development of young Kushum horses. The primary variables analyzed were live weight and body measurements, assessed in relation to age and seasonal changes.

Table 5 presents the individual growth profiles and patterns for foals of the Kushum breed at Bayserke Agro LLP.

Table 5: Age dynamics of measurements and live weight of foals of Kushum breed

Age (days)	Number	Height at withers	Body length, oblique	Chest circumference	Metacarpal girth	Live weight (kg)	Average daily gain (g)
Colts							
3	30	98.7±0.53	80.8±0.47	97.3±0.67	11.5±0.17	51.3±1.87	–
1	29	107.5±0.62	91.6±0.59	107.5±0.64	13.0±0.21	97.6±2.09	1715
3	29	119.2±0.61	97.4±0.64	116.7±0.60	13.5±0.18	143.3±2.17	749
6	27	124.6±0.67	105.7±0.71	125.8±0.74	140.0±0.16	200.7±2.31	638
12	25	128.1±0.59	125.4±0.67	146.1±0.71	15.5±0.11	237.6±2.36	205
18	25	146.5±0.61	144.3±0.65	163.5±0.69	16.0±0.13	361.5±2.87	688
24	22	148.2±0.67	145.7±0.62	168.2±0.66	17.0±0.10	382.2±3.01	115
30	20	151.6±0.58	149.2±0.66	174.3±0.72	18.5±0.08	439.4±3.22	318
Fillies							
3	30	97.2±0.48	80.1±0.53	96.4±0.57	10.5±0.11	49.7±1.62	-
1	30	106.7±0.51	90.8±0.45	106.2±0.52	12.5±0.12	93.5±2.01	1622
3	28	118.1±0.57	96.6±0.51	124.1±0.50	13.0±0.10	139.8±2.28	772
6	28	123.2±0.62	104.5±0.58	144.7±0.47	13.5±0.12	196.5±2.42	315
12	27	126.9±0.53	122.8±0.61	145.6±0.49	14.0±0.09	227.3±2.33	171
18	27	144.5±0.59	143.1±0.59	161.7±0.51	15.5±0.19	334.6±2.626	596
24	25	145.6±0.61	144.4±0.62	167.6±0.54	16.5±0.10	356.2±3.01	120
30	23	148.2±0.58	147.2±0.64	171.3±0.50	17.5±0.09	405.4±3.17	273

As shown in Table 5, foals of both sexes exhibited their most rapid live weight gain between 3 days and 1 month of age. Colts gained 46.3 kg and fillies gained 43.8 kg during this period, corresponding to average daily gains of 1,715 g and 1,622 g, respectively. This high initial gain reflects the excellent milk yield of Kushum mares, as foals rely solely on maternal milk at this stage.

Subsequently, from 1 to 6 months of age, weight gain remained substantial but at a lower daily rate. Colts gained 103.1 kg and fillies 103.0 kg over 105 days, resulting in nearly identical average daily gains of approximately 687 g. A notable decline in growth rate occurred between 6 and 12 months of age. Over this 180-day period, the average daily gain dropped to 205 g in colts and 171 g in fillies. This reduction is attributable to the physiological challenges associated with the foals' first independent wintering period.

Growth patterns from 12 to 30 months of age showed distinct seasonal variation. During the spring-summer period from 12 to 18 months, live weight gain increased significantly to 123.9 kg in colts and 107.3 kg in fillies, with corresponding average daily gains of 688 g and 596 g.

This was followed by a marked slowdown during the subsequent winter period (18 to 24 months), where gains fell to 20.7 kg for colts and 21.6 kg for fillies. Growth rates then recovered modestly during the final spring-summer-autumn period (24 to 30 months), with colts gaining 57.2 kg and fillies gaining 49.2 kg, resulting in average daily gains of 318 g and 273 g, respectively.

Since linear measurements alone do not fully characterize constitutional type, we calculated body build indices for the foals to provide a more comprehensive assessment of their development (Table 6).

Table 6: Age changes in body build indices of foals of the Kushum breed

Age (days)	Number	Body build indices (%)			
		Format	Girth	Boniness	Massiveness
Colts					
3	30	81.7	98.6	11.6	53.4
1	29	85.2	100.0	12.1	78.4
3	29	81.7	97.9	11.3	84.8
6	27	84.8	101.0	11.2	104.0
12	25	98.5	114.1	12.1	113.1
18	25	98.5	111.6	10.9	115.1
24	22	98.3	113.5	11.5	117.6
Fillies					
3	30	82.4	99.2	10.8	54.0
1	30	85.1	99.5	11.7	77.3
3	28	81.8	105.1	11.0	84.7
6	28	84.2	117.5	11.0	105.1
12	27	96.8	114.7	11.0	111.4
18	27	99.0	111.9	10.7	110.8
24	25	99.2	115.1	11.3	115.3
30	23	99.3	115.6	11.8	124.7

Table 6 shows that the format index increased only minimally with age. This is explained by a growth pattern where height at the withers increased more rapidly than oblique body length. Kushum foals are notably tall-legged at birth, and as adults they maintain only a slight 2-3 cm advantage in body length over height. The high mass index indicates that live weight gain outpaced skeletal growth. Meanwhile, the modest rise in the bone mass index corresponds to the thickening of the metacarpal bones.

The analysis of growth and development in Kushum horses from 3 days to 30 months of age revealed clear growth patterns and developmental trends in the foals.

At the Bayserke Agro farm, controlled feeding is practiced to induce fattening in horses. During both pasture grazing and confined feeding, the live weight and body condition of the horses fluctuate. These changes are influenced by several factors, including the quantity and quality of forage, energy expended on thermoregulation, daily grazing duration, and other management conditions.

In the herd-based system, live weight is not constant throughout the spring-summer-autumn period but varies significantly with the seasons. A clear pattern emerges: high weight gain in spring, followed by stabilization or even a slight decline in summer, and a return to increased gains in autumn. Consequently, two distinct seasonal fattening periods are evident and well-defined: spring and autumn.

During the spring fattening period, the most intensive live weight gain occurs from April through June. This coincides with the peak nutritive value and biomass yield of the pasture vegetation. Furthermore, favorable conditions, including reliable water sources, the absence of mass flights of blood-sucking insects, and moderate air temperatures, allow horses to graze for up to 15-20 hours per day, maximizing feed intake.

The results of a spring fattening trial conducted on two groups of Kushum breed colts are presented in Table 7.

Table 7: Change in live weight and average daily gains of colts in the period spring fattening (n=10)

Age	Unit of Measure	Date of Weighing (2021)							
		15-Apr	25-Apr	05-May	15-May	25-May	04-Jun	13-Jun	23-Jun
12 months	kg	310.0	319.5	327.7	335.0	341.2	345.3	347.6	348.5
	g	-	950	820	730	620	410	230	90
24 months	kg	400.6	408.7	415.1	419.6	422.7	424.2	425.1	425.6
	g	-	810	640	450	310	150	90	50

As can be seen from the data in Table 7, colts that came out of wintering with lower average fatness gave high average daily gains of 950 and 810 grams for the first 10 days. The next 10 days they amounted to 820 and 640 g, then on the 30th day of fattening average daily gains gradually decreased to 730 and 450 g. At the end of fattening the average daily gains were only 90-50 grams. In the first 30 days of fattening and young animals high gains are explained by the rapid growth of muscle tissue, then starting from 40 days of fattening growth of muscle tissue slows down and there is already growth of fat tissue. On the average for 64 days of fattening the live weight gain of colts amounted to 38.5 and 25.0 kg, and the average daily gain was 601 and 391 g, respectively.

Stabilization of live weight and its decrease in the summer period is explained by a number of factors. The main ones are the decrease in nutrition and yield of grasses during the period of burning of pasture vegetation, high daytime air temperatures and mass flight of bloodsucking insects that prevent daytime grazing. In the fall, air temperature decreases, blood-sucking insects disappear and as a consequence of the latter factors the

time of horse grazing lengthens. All this explains the increase in live weight of animals in the fall period.

Indicators of change in live weight of colts during the period of fall fattening are shown in Table 8.

The data in Table 7 reveal a clear growth trajectory for the colts during spring fattening. Animals that entered the period with lower initial body condition showed high compensatory gains early on, with average daily gains (ADG) of 950 g and 810 g in the first 10 days. These gains declined to 820 g and 640 g in the next 10-day period and fell further to 730 g and 450 g by day 30.

This pattern can be explained by tissue development dynamics. The high initial gains are attributed to rapid muscle tissue growth. After approximately 40 days, muscle growth slows and fat deposition becomes the primary contributor to weight gain, resulting in the markedly lower final ADG of only 50-90 g.

Over the entire 64-day fattening period, the total live weight gain was 38.5 kg and 25.0 kg for the two groups, corresponding to overall average daily gains of 601 g and 391 g, respectively.

Average daily gains during autumn fattening were lower than in spring. This reduction is attributed to the animals' higher initial body condition at the start of the autumn period, combined with the slightly lower nutritional value and yield of autumn pasture.

In summary, the results indicate that both spring and autumn fattening periods are essential and should be incorporated into the management cycle of horse breeding operations.

The colts were fattened using farm-produced fodder. Rations were formulated based on their individual live weights, and the nutritional quality of the feed was deemed adequate for the trial.

Table 8: Live weight and average daily gain of colts during the autumn fattening period (n=10)

Age	Unit of Measure	Date of Weighing (2021)						
		02-Oct	12-Oct	22-Oct	01-Nov	11-Nov	21-Nov	01-Dec
18 months	kg	349.4	357.9	365.5	371.6	376.7	378.7	379.5
	g	-	850	760	610	510	205	80
30 months	kg	428.7	436.4	443.2	447.7	450.4	452.2	452.9
	g	-	770	660	480	260	180	70

Table 9: Structure and nutritional content of given feed

Feeds	Quantity (kg)	Feed Units	Digestible protein (g)	Calcium (g)	Phosphorus (g)	Carotene (mg)
Colts (18 months)						
Meadow hay	6	2.70	204	40.2	8.4	84.0
Alfalfa hay	4	2.02	316	37.2	8.0	12.0
Barley	2	2.44	140	1.4	7.2	0.8
Wheat bran	2	1.58	260	2.6	20.2	-
Total	-	8.74	920	81.4	43.8	204.8
Colts (30 months)						
Meadow hay	7	3.15	238	46.9	9.8	98.0
Alfalfa hay	5	2.60	395	46.5	10.0	150.0
Barley	3	3.66	210	2.1	10.8	1.2
Wheat bran	3	2.37	390	3.9	30.3	-
Total	-	11.78	1233	99.4	60.9	249.2

Table 10: Digestibility of nutrients of diets

Indicators	Dry Substance	Organic Substance	Protein	Fat	Fiber	Nitrogen-free Extractive Substances
Colts (18 months)						
Intake with feed g	10126	9493	1455	318	2113	5607
Excreted with feces (g)	4324	3598	477	186	1259	1514
Digested (g)	5802	5895	978	132	854	4093
Digestibility coefficient (%)	57.3	62.1	67.2	41.5	40.4	73.0
Colts (30 months)						
Intake with feed (g)	13499	12295	1899	415	2606	7377
Excreted with feces (g)	5305	4389	583	241	1530	1748
Digested (g)	8194	7906	1316	174	1076	5629
Digestibility coefficient (%)	60.7	64.3	69.3	41.9	41.3	76.3

Table 9 details the composition and nutritional content of the feeds used during the fattening period for Kushum foals. The provided rations met the nutritional requirements of the young animals.

The daily feeding regimen consisted of three offerings of roughage. Concentrate feeds were administered twice daily, preceded each time by a portion of roughage.

We determined the apparent digestibility of nutrients using standard methods, calculated as the difference between nutrient intake and fecal excretion. The resulting digestibility coefficients for the fattening diets are presented in Table 10.

Analysis of these data revealed that 30-month-old colts demonstrated higher nutrient digestibility compared to their 18-month-old counterparts.

The digestibility of nutrients varied across components. In both age groups, the lowest coefficients were observed for fat and, most notably, for fiber (40.4-41.3%). Conversely, digestibility was highest for dry matter, organic matter (57.3-60.7% for 18-month-old and 62.1-64.3% for 30-month-old colts), protein (67.2-69.3%), and nitrogen-free extract (NFE) (73.0-76.3%).

The low fiber digestibility can be attributed to the unique equine digestive physiology. Young horses have a gastrointestinal tract that is not yet fully developed. Furthermore, compared to other farm animals, horses possess a relatively small, single-chambered stomach. The primary microbial fermentation of roughage occurs in the hindgut (the colon and cecum), a process that is inherently less efficient for fiber breakdown than the foregut fermentation found in ruminants, which explains the lower digestibility coefficient.

Table 11 presents the live weight data for Kushum foals during the fattening period.

Table 11 demonstrates that foals of different ages, kept under identical fattening conditions but fed diets of varying nutrient density, exhibited different growth rates. While 30-month-old colts achieved a 77.75 kg higher final live weight than 18-month-olds, the younger colts showed superior growth efficiency, surpassing the older group by 15.6% in total weight gain and 20.1% in average daily gain.

Table 11: Live weight and gain of foals at fattening (n= 15)

Indicators	Age	
	18 months	30 months
Duration of fattening (days)	55	55
Live weight (kg)		
At the beginning of fattening	318.90±3.6	402.30±4.1
At the end of fattening	360.70±2.5	438.45±3.4
Live weight gain		
Gross (kg)	41.80±1.17	36.15±2.2
Daily average (g)	764±42.3	636±42.7

To determine meat productivity, colts aged 18 and 30 months were slaughtered on December 8, 2021, following autumn fattening. The slaughter was conducted at the Bayserke Agro farm abattoir, with the results detailed in Table 12.

The colts selected for slaughter were representative of their respective age groups following autumn fattening. While the 18-month-old colts had 19.6% lower live weight and 15.8% lower carcass weight than the 30-month-olds, they showed a 3.3% advantage in slaughter yield.

The morphological composition of the carcass was studied by determining the ratio of muscle tissue with fat to bone.

Table 12: Meat productivity and morphological composition of Kushum foal carcasses

Indicators		Age	
		18 months	30 months
Pre-slaughter live weight (kg)		374.6	448.2
Carcass weight (kg)		199.7	231.3
Slaughter yield (%)		53.3	51.6
Carcass Composition			
Flesh meat	(kg)	164.8	185.5
	(%)	82.5	80.2
Bones	(kg)	34.9	45.8
	(%)	17.5	19.8

The data in Table 12 reveal key differences in carcass composition between the two age groups. Eighteen-month-old colts showed a 2.3% higher yield of saleable meat (flesh) and a more favorable meat-to-bone ratio of 4.7 kg of flesh per 1 kg of bone. In contrast, while 30-month-old colts produced heavier carcasses with 20.7 kg more total flesh, they had a higher bone content (19.8%) and a lower meat-to-bone efficiency (4.1 kg of flesh per 1 kg of bone). This represents a 14.6% lower efficiency compared to the younger group.

In summary, although 30-month-old colts yielded a greater absolute quantity of meat, 18-month-old colts provided a more efficient carcass composition in terms of meat yield and quality.

The farm's herd-based management system, which involves year-round pasture maintenance, contributes to this economic outcome. Concentrated and roughage feeds are reserved primarily for sick or weakened animals, minimizing harvested feed costs. This low-input approach underpins the high economic efficiency of meat production from herd horse breeding for farmers.

Conclusion

The Kushum breed of horses raised at Bayserke Agro LLP in the Almaty region demonstrates excellent adaptation to a year-round pasture-based system. Stallions and mares of this breed significantly surpass Kazakh horses of the Zhabe type in key body measurements and live weight (542 kg vs. 471 kg for stallions; 482 kg vs. 447 kg for mares; $p < 0.01$ to $p < 0.001$), confirming their superior genetic potential for production.

Growth performance during seasonal fattening was robust. The average daily gain was 601 g during spring fattening and 493 g in autumn. Over an autumn-winter period, 18-month-old foals gained 41.8 kg, while 30-month-olds gained 36.15 kg.

Assessment of meat productivity revealed age-dependent trade-offs. While 30-month-old colts produced heavier carcasses (231.3 kg vs. 199.7 kg), 18-month-old colts showed advantages in processing efficiency, with higher slaughter yield (53.3% vs. 51.6%) and a greater yield of saleable meat (82.5% vs. 80.2%).

In conclusion, the Kushum breed exhibits high adaptability, strong growth rates, and desirable meat production traits, demonstrating clear superiority over local analogues in both morphological and productive characteristics. These attributes make it a highly promising breed for sustainable and efficient meat production in the regional context.

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Author's Contributions

Otebayev Zhassulan: Conceived the original idea, data analysis.

Akimbekov Amin: Manuscript writing, abstract, and discussion.

Alpeisov Shokhan: Reviewed and coordinated, materials and equipment engagement.

Gulshad Zhumagaliyeva: Management and manuscript are written.

Kalmagambetov Murat: Designed research methodology and data in interpretation.

Iskhan Kairat: Editing and literature search.

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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