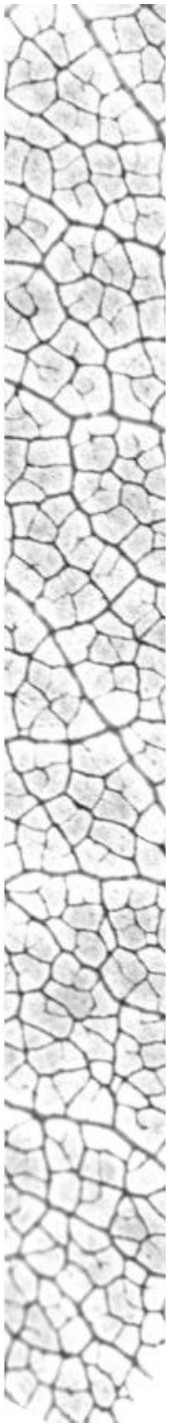

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Productive-biological features of aday breed kazakh horses

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Abstract
Milk mares of Aday breed Kazakh horses have an average live weight of 389.2 kg, a height at the withers of 139.2 cm, an obliquus body length of 142.1 cm, a chest girth of 167.6 cm and a pastern girth of 17.5 cm. In stud getters of Aday breed Kazakh horses, the live weight averaged 438.7 kg and in the Mangistau population 449.8 kg. The measurements of the body were 145.2 - 147.5 - 169.8 - 18.5 cm in the Aday breed, and in the Mangistau population, respectively, were 145.6 - 148.1 - 172.2 -18.5 cm. Mares of the Aday breed with an average live weight of 389.2 kg produce 1617.0 l, and the Mangistau population, respectively, 415.3 kg – 1413 l of milk. It was found that 2.5-year-old stallions of the Aday breed are characterized by a higher bone ratio in comparison with peers of the Mangistau population, the difference was 1.7%. On the contrary, the yield of flesh is lower in stallions of the Aday breed in comparison with the Mangistau population by 10.6 kg or 6.7%. So, for 1 kg of bones, the flesh was obtained from stallions of the Mangistau population of 5.76 kg, and Aday breed of 5.05 kg. The population-genetic structure of the Aday breed Kazakh horses shows the differentiation of the population as a whole. The total number of alleles found in 17 microsatellite loci was 122, including informative alleles - 122, effective alleles - 99.28, and private alleles - 0. Indicators of the average expected heterozygosity range from 0.7235 to 0.8695. According to the Fis coefficient (*individual fixation index*), an excess of heterozygotes was found in all loci. Expected heterozygosity is *He =0.8677*, observed heterozygosity is *Ho =0.8600*. The analysis of the studied parameters of the population-genetic structure of the Aday breed Kazakh horses confirmed the presence of intra-population differentiation of animals in the conditions of the Mangyshlak peninsula.

Keywords: exterior, live weight, milk yield, fattening, slaughter yield, alleles, microsatellite loci

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INTRODUCTION

Horse breeding in the Republic of Kazakhstan has always occupied a special position among other branches of productive animal husbandry. For the countries of the Eurasian Economic Union (EEU), productive horse breeding is of particular importance, due to the breeding of local breeds. Therefore, attention to this sector of animal husbandry and its further development is increasing. Not only meat, but also dairy horse breeding has a great prospect of development in the conditions of the Mangyshlak peninsula of the Republic of Kazakhstan.

For domestic horse breeding of the productive direction, the Kazakh horse of the Zhabe type, bred by traditional selection, is of special importance (Barmintsev 1954, Nechayev 1962, Fedotov 1981, Mursalimov and Satyev 1988, Svechin et al. 1992, Development of meat droving horse breeding in Russia, Chirgin and Semenov 2018, Chirgin and Onegov 2013).

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The biological value of Kazakh horses of the Zhabe type is the bioresource potential for a live weight of 350-370 kg when reaching 2.5 years of age, which makes it highly profitable to grow them for meat (Akimbekov et al. 2017, 2018, 2019, Iskhan et al. 2019).

Of the Kazakh breed of horses of particular interest are Aday breed bred in the desert zone of the Mangyshlak Peninsula.

In terms of breeding and productive qualities, genealogical structure and number of livestock, Aday horses exceed the minimum requirements of the first class standard.

Aday horses are bred in different soil and climatic zones of the Caspian lowland of the Republic of Kazakhstan. Aday horses are capable of being kept on pasture throughout the winter, getting food from under the snow. Therefore, in the conditions of the Mangyshlak peninsula, the development of meat horse breeding, as well as the use of mares for obtaining dairy products, is of great importance. There is little fat in horse meat and young horse meat has high taste qualities. Young horse meat is a valuable component in the production of hard-smoked sausages. Mare milk is used to make a valuable drink - koumiss. Due to its healing properties, koumiss is widely used in the treatment of tuberculosis, as well as a number of gastrointestinal diseases. In this regard, in many areas of the Mangistau region there are farms and workshops for the production of koumiss.

The milkiness of Kazakh mares of Aday breed refers to those productive qualities of horses that are essentially not affected by breeding work.

For 105 days of lactation with year-round pasture content without feeding, the mare of Zhabe Kazakh horses usually produces no less than 800 liters of milk, of which 150-200 liters are usually given to koumiss, and the rest goes to the foal (Akimbekov et al. 2017, Iskhan et al. 2019a, 2019b).

By organizing proper full-fledged feeding, a rational milking regime, the milk yield of mares can be significantly increased and lengthen their lactation period.

Horse meat produced in droving horse breeding contains a high amount of nitrogen-containing substances with a low content of intramuscular fat. Therefore, horse meat is a dietary product available to a significant part of the population of the Republic of Kazakhstan (Akimbekov et al. 2019¸Chirgin and Semenov 2018).

Meat droving horse breeding requires minimal costs, since local feed is used. An unlimited number of pasture lands significantly contributes not only to an increase in the number of herd horses, but also to an increase in the production of high value meat - horse meat (Akimbekov et al. 2019, Barmintsev 1954, Nechayev 1962).

For the further development of productive horse breeding, it is necessary to improve the traditional methods of evaluating and selecting Aday horses based on economically useful characteristics in the conditions of the Mangyshlak peninsula, which make it possible to produce cheap, environmentally friendly horse meat and koumiss, which is of particular relevance.

Novelty

For the first time, the meat and milk productivity of Aday breed Kazakh horses in the conditions of the Mangyshlak peninsula were studied, sequentially selected and evaluated for productivity taking into account current trends in genetics and breeding.

The Aim and Main Objectives of the Study

The aim of the study is to conduct a comprehensive assessment of Aday horses by productivity (meat, dairy).

Based on the aim the tasks are set:

- To study the biological features of the formation of the exterior and milk productivity of Aday horses in the Mangyshlak peninsula of the Republic of Kazakhstan.

- To conduct a comprehensive assessment of the fattening capacity and meat productivity of the Aday breed Kazakh horses in the Mangyshlak peninsula of the Republic of Kazakhstan.

- To assess the current state of the population-genetic structure of the Aday breed Kazakh horses of the Zhabe type based on the polymorphism of microsatellite DNA loci.

METHODS OF STUDY

Studies on the biological features of the formation of exterior and milk productivity of Aday horses in the Mangyshlak peninsula were conducted in the conditions of «Taushyk» LLP in the Tupkaragan district of the Mangistau region of the Republic of Kazakhstan in the period 2018 and 2019.

The experimental mares were measured and weighed to characterize their development and body type. From each animal took 4 measurements: height at the withers, obliquus body length, chest girth and pastern girth with further determination of the live weight (Manual for the evaluation of local breeds of Kazakhstan 2014).

The live weight of mares was set by weighing on a single-ton scale at the beginning and end of lactation before morning feeding and watering.

The milk mares keeping in the autumn-winter period is stable-pasture, and in the spring-summer - pasture.

Mares were milked manually 5 times a day, with breaks between milking in 2-2. 5 hours.

The commercial milkiness of mares was determined monthly during lactation by the method of control milk yields, twice a month on two adjacent days. Milk productivity was calculated taking into account the milk sucked at night by the foal according to the formula of I. A. Saigin (Saigin 1963).

Chemical analysis of mares milk was carried out in the laboratory of the NJSC «Kazakh National Agrarian

University» using The MilkoScan analyzer. At the same time, the content of protein, fat and sugar in milk was determined. The percentage of milk solids non-fat «MSNF» was determined by the difference between the indicators of milk and distilled water on the «MSNF» scale.

Spring fattening was carried out from April 12 to June 14, since during this period, vegetation of ephemera and other vegetation occurs. Autumn fattening was carried out from October 05 to November 24 at the time of secondary vegetation of deserts and semi-deserts on the Mangyshlak peninsula.

The fattening qualities were evaluated by the growth of the live weight of the stallions selected for the study for 57 days in the spring and for 53 days in the autumn. Animals were watered 3 times a day at fattening.

Meat productivity was studied at the slaughtering point of the farm using the methodology of the Institute of Horse Breeding (Methods for determining the meat productivity of horses 1974) and in accordance with the technological instructions adopted in the meat industry.

All experimental data were processed using the biometric method used for small samples (Baimukanov et al. 2019).

Biological samples (hair bulbs) of 33 livestock from «Taushyk» LLP, Tupkaragan district of the Mangistau region, served as the material for DNA research. Biomaterials were collected in 2019.

DNA isolation was performed in accordance with the Protocol of the reagent manufacturer (Invitrogen, Applied Biosystems, USA). Multiplex genotyping of horses was performed using a set of StockMarks Horse (Applied Biosystems, USA) at 17 loci recommended by the International Society for Animal Genetics (ISAG).

Identification of amplification products was performed using the ABI Seq Studio genetic analyzer (Applied Biosystems, USA) using capillary electrophoresis. The decoding of the obtained graphical results was performed in the Gene Mapper 5.0 program.

To characterize the polymorphism used the following indicators: the frequency of alleles, average observed and expected heterozygosity and average heterozygosity for the loci, number of alleles at the locus, the number of informative alleles (often with a frequency greater than 1%), the number of private (rare, with a frequency of less than 1%) of alleles in the locus, effective number of alleles and individual fixation index Fis.

To calculate population-genetic indicators, we used a statistical package (Iskhan et al. 2019) and a software package of our own development in the Fortran Power Stationv algorithmic language.2.0 (Nurbayev et al. 2017).

Determined the frequency of occurrence of alleles, minimum, maximum, and average number of alleles, frequency of alleles, number of informative alleles, effective number of alleles, the number and frequency of private alleles.

Allele frequencies were calculated separately for each locus using the formula:

$$p_i = \frac{N_p}{2N} \quad (1)$$

Where p_i - the frequency of occurrence of the *i*-th allele, *Np* - the number of allele *i* in the sample, *N* - the number of livestock in the sample.

The number of informative alleles was calculated as the number of alleles in a population with a frequency greater than 1%.

The number of effective alleles, i.e. the number of alleles occurring with equal frequency in an ideal population, which is necessary to obtain the same degree of homozygosity or genetic diversity in a real population, was calculated using the formula:

$$Ne = \frac{1}{1 - He} \quad (2)$$

where *Ne* - the number of effective alleles in the population, *He* - the average expected degree of heterozygosity.

The number of private alleles was calculated as the number of alleles in a population with a frequency of no more than 1%.

The average observed degree of heterozygosity (*Ho*) was calculated for each locus as the ratio of the number of heterozygotes to the total number of animals studied. To calculate the *Ho* of an individual, the arithmetic mean of *Ho* was found for all 17 loci studied.

The average expected degree of heterozygosity (*He*) was calculated for each locus using the following formula:

$$H_e = 1 - \sum_i p_i^2 \quad (3)$$

where p_i – the frequency of occurrence of the *i*-th allele. For the calculation of *He* of individual, the arithmetic mean of *He* was found for all 17 loci studied.

The individual fixation index (Fis) - coefficient of individuals relative to subpopulations is a measure of the reduction in heterozygosity of an individual due to nonrandom mating within each subpopulation. The formula was used for the calculation:

$$F_{is} = (H_e - H_o) / H_e \quad (4)$$

RESEARCH RESULTS

Biological Features of the Exterior of Aday Breed Kazakh Horses

To obtain a complete zootechnical characteristic of development and type of the body, experimental mares were measured and weighed. Data on live weight and body measurements of mares are given in **Table 1**.

Table 1. Exterior of milk mares of the Mangistau population and Aday breed of Kazakh horses

Features	Mangistau population (n = 15)		Aday breed (n = 15)		The truthfulness of the difference	Elite class standard
	X±m$_x$	Cv, %	X±m$_x$	Cv, %	td	
Live weight, kg	415.3 ± 3.79	1.42	389.2 ± 4.21	1.49	4.6	400-410
Sizes, cm:						
Height at the withers	140.9 ± 0.45	0.60	139.2 ± 0.50	0.57	2.5	143-144
Obliquus body length	143.4 ± 0.51	0.90	142.1 ± 0.53	0.79	1.78	146-147
Chest girth	170.5 ± 0.58	0.87	167.6 ± 0.621	0.81	3.4	168-170
Pastern girth	18.3 ± 0.15	1.37	17.5 ± 0.16	1.31	3.6	18.0

Table 2. Exterior of stud getters of the Mangistau population and Aday breed of Kazakh horses

Features	Mangistau population (n = 15)		Aday breed (n = 15)		The truthfulness of the difference	Elite class standard
	X±m$_x$	Cv, %	X±m$_x$	Cv, %	td	
Live weight, kg	449.8 ± 368	468	438.7 ± 4.16	4.27	2.0	420
Sizes, cm:						
Height at the withers	145.6 ± 0.49	1.69	145.2 ± 0.53	2.16	0.55	145 - 146
Obliquus body length	148.1± 0. 64	2.17	147.5 ± 0.71	2.33	0.63	147- 148
Chest girth	172.2 ± 0.66	1.76	169.8 ± 0.68	2.18	2.55	170 - 172
Pastern girth	18.5 ± 0. 15	5. 03	18.5 ± 0.19	6.11	-	18.5 – 19.0

Table 3. Milkiness of mares of the Mangistau population and Aday breed in liters (n by 15)

Live weight of mares, kg	The actual milk yield		milkiness		Per 100 kg of live weight
	For day	For 105 days of lactation	For day	For 105 days of lactation	
Mangistau population					
415.3 ± 3.79	5.61 ± 0.14	590. 1 ± 4.52	13.46 ± 0.42	1413.3 ± 28.3	340
Aday breed					
389.2 ± 4.21	6.42 ± 0.15	674.1 ± 3.97	15.40 ± 0.38	1617.0 ± 25.7	415

Found that milk mares of Aday breed Kazakh horses have an average live weight of 389.2 kg, height at withers of 139.2 cm, obliquus body length of 142.1 cm, chest girth of 167.6 cm, and pastern girth of 17.5 cm.

Mares of the Mangistau population Kazakh horse are superior in live weight and body size to their peers of the Aday breed. In particular, the live weight was 415.3 kg, the height at the withers is 140.9 cm, the obliquus body length is 143.4 cm, the chest girth is 170.5 cm and the pastern girth is 18.3 cm.

In the Mangistau population, the difference in live weight, height at the withers, chest girth and pastern girth in comparison with horses of the Aday breed is highly reliable, td is 4.6, 2.5, 3.4 and 3.6, respectively (P >0.999). The truthfulness of the difference in the obliquus body length is low (td =1.78), but the reliability of the Student's table is P >0.90.

In general, mares of the Aday breed Kazakh horses are inferior to the minimum requirements for animals of the elite class in size and live weight, but they meet the standard of the first class.

Stud getters of both groups by size and live weight meet the standard of the elite class (**Table 2**).

Table 2 shows that the most stable results of variability (C_V) in stud getters of both groups are observed in height at the withers 1.69 – 2.16, obliquus body length 2.17 – 2.33 and chest girth 1.76-2.18. Higher variability in stallions by pastern girth 5.03-6.11 and live weight 4.86 – 4.27. High variability of these characteristics creates more favorable conditions for further selection and breeding work, increasing its efficiency.

The difference between live weight and chest girth between Mangystau population and Aday breed truthfully td =2.0 and 2.55 (P>0.99), the difference between the height at withers, obliquus body length not truthfully td =0.55 – 0.63 (P<0.90).

Milk Productivity of Mares

Milk productivity of mares was determined monthly during 105 days of lactation in control and experimental groups. The experimental animals were typical in appearance, body size, and live weight.

The total milk productivity of mares is directly dependent on the duration of lactation, as well as on the nature of the lactation curve. In most farms on the Mangyshlak peninsula, milking mares have seasonal and limited characteristics to the period from May to August.

The lactation curve is determined by the level of milk productivity and individual characteristics, the physiological state of animals, as well as the conditions of keeping and feeding. It was found that lactation curves that characterize changes in the milkiness of mares of different breeds during lactation have a high variability. Kazakh horses of Aday breed had higher milk productivity throughout lactation (**Table 3**).

Table 3 shows that for 105 days of lactation, the milk yield of mares of the Aday breed was 1617.0 l, the Mangistau population - 1413.3 l, and the commercial yield was 674.1 and 590.1 l, respectively.

Thus, the milk yield of Aday breed mares exceeds by 14.2 % or 84.0 l than that of animals of the Mangistau population. According to the milkiness index (calculated per 100 kg of live weight) of mares, high indicators were also found in Aday breed mares (415).

Table 4. Change in milk productivity of mares by months of lactation, l

Indicators of milkiness	Month of lactation			
	May II	June III	July IV	August V
Mangystau population				
For day	13.78 ± 0.26	14.42 ± 0.28	13.60 ± 0.31	10.16 ± 0.28
For month	427.18 ± 5.74	432.50 ± 4.93	421.53 ± 5. 01	132.12 ± 3.39
Aday breed				
For day	15.65 ± 0.29	17.30 ± 0.25	15.36 ± 0.27	10.52 ± 0.23
For month	485.10 ± 4.08	518.95 ± 3.96	476. 16 ± 4.68	136.79 ± 3.12

Table 5. Results of control slaughter of stallions

Indicators	Mangistau population (n=4)	Aday breed (n=4)
Pre-slaughter live weight, kg	359.5±3.2	351.7±3.5
Carcass weight, kg	198.1±2.9	189.5±1.6
Slaughter yield, %	55.1±0.1	53.9±0.2
Flesh weight, kg	168.8	158.2
Bone weight, kg	29.3	31.3
Flesh yield, %	85.2	83.5
Bone yield, %	14.8	16.5

The milkiness of mares of both groups during 105 days of lactation was far different (**Table 4**).

As can be seen from the data in **Table 4**, the higher productivity of the mare was shown for 2-3 months, then the milk yield gradually decreases, and more sharply by the end of lactation. This is due to the fact that the onset of foal yield decreases, especially with the onset of its second half.

Thus, when seasonal milking mares «Taushyk» LLP due to the selection of mares Aday breed of milk and meat productivity rather than Mangystau population for meat productivity it is possible to significantly increase milk productivity of milk mares.

The Fattening of Horses

A.R. Akimbekov, D.A. Baimukanov, Yu.A. Yuldashbayev (Akimbekov et al. 2018) believe that «using the biological characteristics of herd horses and fescue-feather-sagebrush grass pastures of the steppe zone, the production of horse meat can be increased, increase the fatness of foals».

We conducted a spring fattening on 2 groups of stallions of Aday breed, while the fatness of the stallions that came out of the winter was lower than the average fatness. So, for the first 10 days, the stallions gave 650 and 570 g of average daily growth. Starting from the 20th day of feeding, the increase gradually decreased, and in the last 11 days of fattening reached only 54-55 g per day.

In the autumn period, the most intensive fattening took place between 5 and 25 October, when the horses gave 255-285 g of average daily growth per day. Then growth and began to decline, as the horses reached the highest fatness.

Slaughter and Meat Qualities

Slaughter of 2.5 year-old stallions after autumn fattening was carried out (**Table 5**).

It was found that the weight of the carcass of the Aday breed stallions was 8.6 kg (4.5%) less than the peers of the Mangistau population.

According to the indicator of slaughter yield, the stallions of the Mangistau population have an advantage in comparison with the Aday ones by 1.2%.

Thus, the Aday breed of Kazakh horses are characterized by a higher bone ratio in comparison with peers of the Mangistau population, the difference was 1.7%. The obtained data characterize the features of the formation of meat productivity of Kazakh horses during the fattening period.

So, for 1 kg of bones, the flesh was obtained from stallions of the Mangistau population of 5.76 kg, Aday breed of 5.05 kg. Data obtained are consistent with the studies conducted by A.R. Akimbekov, K.Zh. Iskhan et al (Akimbekov et al. 2019), A.R. Akimbekov, D.A. Baimukanov, Yu.A. Yuldashbayev (Akimbekov et al. 2018).

Common-Breed (Population) Differentiation

The characteristic of the Aday breed of Kazakh horses in the context of population-genetic breed differentiation using modern analytical methods of identification by microsatellite DNA is presented.

For the general characteristics and positioning of this breed, the following genotyping results of 17 microsatellite loci are proposed, which are given in **Table 6** in more detail.

In general, the analysis of the allele fund of this sample of Aday breed Kazakh horses of the Zhabe type revealed a range of values typical only for Aday breed. VHL 20, HTG10, HTG6, AHT5, ASB 23, HTG 7, ASB 17, Ca425c 9 and 8 alleles are the most polymorphic of the 17 MS loci for this breed of Kazakh horses, the least polymorphic loci are HMS7 and HMS1 (4 and 5 alleles each). Genetic intra-breed diversity (polymorphism) reflects the presence of informative, effective alleles and the presence of rare (private) alleles. A total of 122 alleles were identified, of which 122 were informative, 99.23 were effective, and 0 were private. The average number of alleles for all loci was 7.17, for all informative alleles -7.17, for effective alleles -5.84, and for private alleles – 0. The absence of private alleles indicates the consolidated status of Kazakh horses of the Aday breed.

The level of the average expected heterozygosity of horses for loci varies from 0.7235 (in the HMS7 locus) to 0.8695 (HTG6), the average for all loci is 0.8226. This pattern is also observed for the levels of average observed heterozygosity.

Table 6. Identified allelic variants of MS loci of the Aday breed Kazakh horses (sample size of 33 animals)

Locus MC	N	Na	Npr	Ne	He	Ho	Fis
VHL20	9	9	0	7	0,8629	1	-0,15888
HTG4	7	7	0	5	0,7786	0,7878788	-0,01192
AHT4	7	7	0	5	0,7963	0,8181818	-0,02748
HMS7	4	4	0	4	0,7235	0,9393939	-0,2984
HTG6	8	8	0	8	0,8695	0,9090909	-0,04553
AHT5	8	8	0	6	0,8312	0,9090909	-0,09371
HMS6	7	7	0	6	0,8392	0,8787879	-0,04717
ASB23	8	8	0	6	0,8384	1	-0,19275
ASB2	7	7	0	6	0,8424	0,9090909	-0,07917
HTG10	9	9	0	7	0,8522	1	-0,17343
HTG7	8	8	0	5	0,8065	0,8787879	-0,08963
HMS3	7	7	0	6	0,8182	0,9090909	-0,11109
HMS2	6	6	0	6	0,8182	0,8484848	-0,03701
ASB17	8	8	0	7	0,8462	0,8484848	-0,0027
LEX3	6	6	0	5	0,7907	0,969697	-0,22638
HMS1	5	5	0	5	0,8121	1	-0,23138
CA425	8	8	0	7	0,8587	1	-0,16455
Total	122	122	0	99,289	13,9848	15,606061	-1,99118
Average	7,1761	7,1764	0	5,8405	0,8226353	0,9180036	-0,11713

Note: *N* - the number of alleles, *Na* – the number of informative alleles (*Na*≥1%), *Npr* – number of private alleles (*Npr*<0,1%), *Ne* –number of effective alleles, *He* – average expected heterozygosity, *Ho* - average observed heterozygosity and *Fis* - *individual fixation index*.

According to one of the indicators of population differentiation, the Fis coefficient (*individual fixation index*), an excess of heterozygotes was found in all loci.

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