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Genetic Studies and Breed Diversity of Kazakh Native Horses: A Comprehensive Review

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Abstract

This comprehensive review analyzes the state of horse breeding in Kazakhstan, examining its historical context, current status, genetic studies, and future prospects. Drawing on historical records, government reports, academic studies, and genetic research, this review provides insights into the genetic diversity of Kazakh native horse breeds. The review traces the historical trajectory of horse breeding, explores its significance for the economy and culture, and discusses current population trends. Genetic studies reveal untapped potential for breed improvement. Kazakhstan's horse breeding faces opportunities for growth and development, requiring efforts to increase the horse population and harness genetic potential for productivity. This review emphasizes the need to preserve the gene pool of Kazakh native horses, ensuring sustainability and cultural significance.

Introduction

Dating back over a millennium, the vast steppes of present-day Kazakhstan were home to equine breeds closely akin to the contemporary Kazakh native horses, specifically the Dzhabe type. These animals were integral to the nomadic peoples, fulfilling roles in transportation, as well as meat and dairy production. The evolutionary trajectory of these horses was significantly shaped by a rigorous process of natural selection, propelled by the challenging climatic conditions of the region, alongside a systematic approach to artificial selection aimed at optimizing traits suited for the nomadic economy's equine requirements. This selection process was characterized by the management of extensive horse herds under fluctuating environmental conditions, ensuring the survival and minimal phenotypic alteration of Kazakh native horses across centuries [1, 2].

The Kazakh breed of horses was influenced by other breeds: the Mongolian, Arabian, Akhal-Teke, Karabair, and later the English Thoroughbred, Oryol trotter and Don horse [3].

The breeding area of the Kazakh native horse is 3,000 km from west to east and 1,500 km from north to south. The northern part of this territory is occupied by a zone of steppes, turning south into semi-desert and desert and covering the main part of Kazakhstan. Kazakhstan is characterized by a dry continental climate [4]. Precipitation is only 100-300 mm per year, with the exception of better moistened mountainous areas. Due to insufficient moisture, the vegetation cover is mainly represented by drought-resistant wormwood, saltwort, dense bush grasses and ephemera. In spring, the pastures of Kazakhstan are represented by highly nutritious grass. However, in most areas, except for mountain meadows and northern steppes, the vegetation dries up already at the beginning of summer, which causes summer underfeeding of livestock and horses. The effect of summer underfeeding in semi-desert and desert areas is exacerbated by heat. The average July temperature in Kazakhstan varies within 20-28°C, sometimes rising to 40°C in the daytime, and in some places up to 45°C. The soil surface in the south heats up to 68-70°C. Limited water supply has a significant impact. Often, horses are forced to go to a watering hole 10 km away and make up to 30 km or more per day on a pasture, including transitions to watering places. In autumn, the situation improves: although the grass does not grow every year and not in all areas, but after autumn rains and frosts, wormwood and saltwort become well eaten, which gives animals the opportunity to get fat for the winter [5]. In the north of Kazakhstan, the average January temperature is 16-18°C below zero, while in the south 3-5°C below zero. But sometimes wintering here is difficult due to strong winds and snowstorms. In the more southern regions of Kazakhstan, where the weather is unstable in winter, icy conditions are frequent, preventing grazing. As noted earlier, many adaptive qualities that arose as a result of natural selection from the ancestors of the Kazakh native horse have survived to this day [3, 7].

The Kazakh native horse is characterized by a strongly developed jaw with large teeth and powerful chewing muscles, which is the result of feeding on coarse-stalked wormwood, saltwort and hard dense bush cereals. The large body length of the Kazakh native horse is associated with a good development of both the heart and lungs, and the digestive organs, which is the result of movement on pastures with sparse herbage and remote watering places and feeding on roughage [8, 9]. Feeding on low-growing vegetation determined the preservation and formation of a low set neck and a straight back. A certain coarseness of the Kazakh native horse, especially in the northern parts, is due to well-developed subcutaneous tissue, which is the place of deposition of fat reserves that save the body during periods of undernutrition and play the role of a heat insulator, as is generally observed in cattle of cold countries. The winter coat of the Kazakh native horse is distinguished by its density and complex structure. It consists of the so-called "undercoat" - downy hairs with a diameter of 22-25 microns and a length of 2-3 cm. In the spring, horses shed and become covered with short hair, which does not prevent sweat from evaporating from the surface of the skin [3].

The adaptive qualities of the Kazakh native horse should include the nature of the growth of young animals: growth retardation caused by temporary undernutrition is compensated by rapid growth in subsequent favourable periods. The Kazakh native horse is able to grow at the age of four, five and even six years, and with abundant feeding, it can complete growth by three years [10].

The vast territory of Kazakhstan and the peculiarities of horse keeping and use in different regions have led to the fact that the composition of Kazakh native horses is heterogeneous and several types are distinguished. There are two types of Kazakh native horse that have developed over the years. They are the Dzhabe and the Adaev. Kazakh native horses of the Dzhabe type are the meat and dairy direction of the breed. They are relatively short, but have a stronger constitution, and therefore can weigh up to 460 kg. They are well adapted to cold weather and hard work. Horses of the Adaev type are more focused on racing specialization. They are taller and lighter in constitution than the base breed., they tolerate severe frosts worse [10]. Also, on the basis of the Kazakh

native horse breed were created the Kostanay riding horse breed, the Mugalzhar and the Kushum meat and dairy horse breeds [11].

Thus, the Kazakh native horse breed has a world gene pool and can improve other horse breeds animal breeds in terms of adaptability, fertility, productivity, and endurance. All these main characteristics of the Kazakh native horse breed have been genetically embedded in the breed and have been preserved to this day. Therefore, it is important to study the aboriginal horse breeds that have rare alleles in their genome.

Methods

Literature Search Strategy and Selection Criteria

The literature search aimed to gather relevant information on Kazakh native horse breeding, genetic studies, and breed diversity. It included peer-reviewed research articles, academic studies, government reports, and historical records related to Kazakh native horse breeds, their genetic diversity, and their historical and cultural significance.

Databases Consulted

Several databases were consulted to conduct a comprehensive literature search. These databases included: PubMed, Web of Science, Google Scholar, ResearchGate.

Search Terms Used

The following search terms and combinations thereof were used in the literature search: "Kazakh native horse breeding", "Genetic studies of Kazakh native horses", "Kazakh native horse history", "Kazakh native horse genetic diversity", "Mugalzhar horse breed", "Kushum horse breed", "Dzhabe horse breed".

Criteria Applied for Inclusion or Exclusion

The following criteria were applied to include or exclude material during the literature search:

Relevance: Only materials directly related to Kazakh native horse breeding, genetics, and breed diversity were considered for inclusion.

Publication Date: Materials published from the year 2000 onwards were given priority to ensure that the information gathered was up-to-date. However, historical records that provided valuable insights into the topic were included regardless of their publication date.

Geographical Relevance: Materials focusing on Kazakh native horse breeds and their breeding in the geographical region of Kazakhstan were included.

Discussion

The Current State of Horse Breeding in Kazakhstan

Horse breeding in the Republic of Kazakhstan is a traditional branch of livestock breeding. The availability of sufficient natural pastures (185 million hectares), the centuries-old experience of the Kazakh people in breeding herd horses, the solvent demand for horse-breeding products and the great interest in national equestrian sports create a prerequisite for the development of productive and breeding horse breeding in the Republic [12]. Indeed, horse breeding is of interest not only as a supplier of organic food but also as a sub-industry producing raw materials for the leather, footwear, lightweight, pharmaceutical, cosmetics and biological industries [13, 14].

There were 4,640,000 horses in Kazakhstan before the sad consequences of collectivization, after which their number decreased almost tenfold. Horse breeding met such a fate for the second time at the end of the last century, during the period of realignment and transition to a market economy. Even then there were less than one million horses, and only now, with great difficulty, has it been possible to stabilize the population, with a slight but steady increase that has made it possible to exceed the limit of one million horses [15].

At the beginning of February 2022, in Kazakhstan the total number of horse population in different areas of economic use has increased and reached 3,443,539 horses [16]. Thus, the number of horses in the Republic has stabilized and increased by 9.6 percent in 2 years. However, to meet the needs of farms and the economy of Kazakhstan, the number of horses should be at least 4 million [17].

The productive horse breeding of Kazakhstan has now developed into an almost independent livestock sector, which faces specific tasks - the production of horse meat and koumiss (fermented mare's milk) [17].

Private farms continue to be the main producers of horsemeat. Private farms account for 78% of the total meat produced; farms account for 20.0% and agricultural enterprises account for 2.0%. Meat productivity of local horse breeds is characterized by: Slaughter yield 56-62%, meat yield 75-82%, high protein content 20-24%. The fat has a high biological value and gives the meat its marbling [17].

The dairy horse breeding of the country is represented mainly by factories and farms for the production of koumiss. Milk yield depends on horse breed, duration of lactation period, number of milking per day, individual characteristics of mares and feeding

conditions. Mares of the Kazakh breed have good milk productivity. Milk yield of selected Kazakh mares during the lactation period is 2200 litres of milk (average daily milk yield is 14.2 litres). The chemical composition of mare's milk differs considerably from that of other farm animals. The milk of mares of the Kazakh breed of the Zhabe type contains on average: 1.4% fat, 2.8% protein and 6.43% sugar [18].

The largest number of breeding horses of the productive direction is concentrated in the Almaty region – 51,100 heads of horses or 15.6%, East Kazakhstan - 34,300 or 8.7%, Zhambyl – 31,600 or 23.2%, Aktobe – 26,020 or 10.7%, Turkestan 15,800 or 4.4%, Pavlodar – 11,800 heads of horses or 6.4%. The average indicators of horse livestock in Kazakhstan are concentrated in the West Kazakhstan regions - 10,300 heads or 5.3%, Kyzylorda – 6,900 or 4.7%, Karaganda – 6,800 or 2%, North Kazakhstan – 4,400 or 3.4%, Mangystau - 2,500 or 2.9%, Atyrau – 1.7 or 2 Less than 2% of breeding horses are in Akmola – 2,900 or 1.4% and Kostanay regions – 2,100 heads or 1.7% [16].

The analysis of the number of horses as of 01.01.2020, according to productive breeds, is 204,842 heads, of which: Kazakh – 172,682 heads (including 80,196 mares), Kushum – 10,741 horses (including 3,922 mares), Mugalzhar – 16,290 (including 7,026 mares), Adaev type of horses – 2,200 (including 1,040 mares), Kabinsky type – 202 (including 123 mares). Horse-drawn – 1357 heads, of which: Kostanay – 86 heads (including mares - 24), Don – 1,271 (including mares – 389) [16].

The horse breeding industry of Kazakhstan has every chance to take a leading position among countries, become competitive, import horse meat to the countries of Europe and the Commonwealth of Independent States. There are all possibilities for this: a significant number of horses of productive breeds that have excellent adaptability to natural forage conditions; extensive pasture lands, thanks to which it is possible to significantly reduce production costs [19, 20].

In comparison with the European Union countries, the maintenance of horses from an economic point of view in the Republic of Kazakhstan is cheaper and easier, since there are extensive pasture lands. Consequently, the cost of horse meat, the production of mare's milk is significantly lower, which is quite profitable for local producers of these products [21].

Many authors conclude that the productivity potential of horses has not yet reached the maximum possible upper limit. It is necessary to improve existing ways of keeping, reproduction, and rearing horses, allowing to increase productivity by at least 10-15%. And to improve the quality of animals used in both dairy and meat horse breeding in the republic, genetic methods of identification of herd horses should be used [22].

Kazakh native horse of the Dzhabe type

The Kazakh native horse Dzhabe with a strong, somewhat rough constitution was formed in the southern regions of the Aktobe region and is now becoming widespread throughout the Republic [23]. The work of more than one generation of breeders has been expended on the creation of a modern Dzhabe type horse. Since 1960, breeding work with this type has been carried out on the basis of breeding massive animals with good meat forms. Kazakh mares of the Dzhabe type were the maternal basis for the breeding of the Kostanay and Kushum breeds of horses, as well as on the basis of purebred breeding of the Mugalzhar breed.

It is well known that for production of horse meat the Kazakh native horses of the Dzhabe type are of great value, since they distinguish by exclusively strong, often even horny constitution, magnificent fitness to semi-desert and steppe pastures [24]. Under favourable pasture conditions, Dzhabe horses are able to accumulate large reserves of fat under the skin and on internal organs (up to 30-50 kg), which the horse gradually spends to compensate for the lack of nutrients in winter or during the burnout of vegetable pastures [1]. They have rather rugged head, not a long meaty neck, a wide and deep-set trunk, a wide back, brawny croup, bony legs, a mane and a tail of this horse are thick, long, legs have short fetlocks. Their skin is thick enough and dense. Color is bay, dark bay or red, occasionally greyish or grey.

Figure 1: Kazakh native horses of the Dzhabe type [13].

In structure of breeds, used for meat production, Dzhabe type horses occupy 34.5% of total specific weight, and that characterizes their high meat productivity [25]. The measurements for stallions include a height at withers ranging from 141.3 cm to 143.2 cm, an oblique length of the trunk between 151.5 cm and 152.0 cm, a large chest girth spanning from 179.2 cm to 184.3 cm, and a metacarpus girth varying from 19.4 cm to 21.3 cm. In comparison, mares exhibit slightly lower measurements (in centimetres) with a

height at withers ranging from 141.3 cm to 143.2 cm, an oblique length of the trunk between 143.2 cm and 148.9 cm, a chest girth ranging from 167.1 cm to 179.3 cm, and a metacarpus girth ranging from 18.3 cm to 19.3 cm, respectively. Considering their small measurements, Kazakh native horses of the Dzhabe type have a high live weight reaches for mares - 440, for stallions – 503 kg. The fertility of Kazakh native horses Dzhabe type is quite high - 95-97 foals per 100 mares [26].

After feeding on a pasture, adult horses of this type have rather high slaughter qualities: the yield of meat and fat is 53-57% (sometimes 60%), carcass weight is 230-250 kg, the yield of all meat products, including offal, is 260-280 kg. [10]

With the development of herd horse breeding, the Kazakh native horse of Dzhabe type gains importance due to its high adaptability, which allows to keep the herds on almost the same pasture all year round, even in winter, when frosts reach to -40 - -50 °C. [10]

Kazakh native horse of the Adaev type
The Adaev type of the Kazakh native horse is bred in the Aral-Caspian desert region. The Adaev horse is a ride type horse. It was bred on the basis of the Akhal-Teke, Yomud and Karabair breeds. It is characterized as an excellent workhorse, irreplaceable in animal husbandry. Moreover, in desert conditions of the Mangystau region, where relative humidity drops down to 7%, this horse grows and maturates well, it is used as a draft animal, and also in meat and dairy production [27].

The most detailed description of the Adaev horse contains information, underlining that this breed, bred during many centuries in conditions of sharply continental climate in herds, has got a series of specific biological adaptive traits, characterizing this animal as highly adapted to severe climate [25]. This breed distinguishes, first of all, by fast fattening, high milk producing ability, optimum delivery terms. This is exclusively efficient and hardy horse, capable to cover in mount condition about 300 km per day. Exterior of this horse characterizes it as a medium-size animal with a harmonious body type and strong constitution. The average live weight for stallions of the Adaev line is approximately 442 kg, while for mares, it is around 412.7 kg. The corresponding body mass index values are approximately 146.6 for stallions and 142.9 for mares [25].

On the basis of revealed biological laws at pasture herd breeding of the Adaev horse scientists give a series of practical advice on perfection of technologies of such horse ranching. For the purpose of increase of production of horse meat, improvement of its quality, production of koumiss and high-quality tanning raw

material it is recommended to all enterprises (of all forms of ownership) of the Aral-Caspian zone to introduce widely breeding of the Adaev horse [25].

The recommended method of their ranching – year-round, pasturable. The breeding method - thoroughbred, the coupling method - herd. For the purpose of growth of production, improvement of quality and decrease of cost price for horse meat, and also for increase of gain of live weight coupling is expedient in April-May, for subsequent delivery in March-April [28].

Figure 2: Kazakh native horses of the Adaev type.

Kushum breed
Hard work of scientists-selectors of Kazakhstan is marked by approbation of a new breed group of horses, named the Kushum breed. This is the first-ever breed of horses, which main characteristics are not draft, but meat and dairy. The new breed is created in farm enterprises of the Ural and Aktyubinsk Oblast. This is a breed of meat-and-milk direction of productivity, created by the method of complex reproductive crossing of the Kazakh mares with stallions of the Trotter, Don, thoroughbred riding breeds and specific desirable type horse breeding. The Kushum horses distinguish by solid constitution and a riding-draft constitution type. Mares are prolific, have high milking capacity, give 80-85 foals per 100 mares. Breed is non-uniform by content. There are three intra-breed types: riding, main and solid. For meat horse breeding the most interesting type – the solid type of the Kushum horses [13].

Genetic potential of the Kushum breed by live weight reaches for mares - 577 kg, for stallions – 640 kg. Currently the maximum number of stallions, used in base farm enterprises, is represented by animals from the specially created stud farm line «Krepysh» - 11 horses (57.9%), and also from the line «Grom» - 5 horses (26.3%) and the line «Samocvet»- 3 horses (15.8%). Stallions of the line «Krepysh» have above average (159.2 cm), elongated oblique length of a trunk (165.4 cm), large chest girth (197.2 cm) and metacarpus girth (21.5 cm), high live weight (582.2 kg) [13].

The complex of exterior-productive research of the Kushum breed, is represented in [12]. For Kushum horse the following features are typical: a proportional head, a middle length neck, a deep-set compact trunk, a well-developed croup, strong lean feet. By fertility and adaptation to herd-snowfields ranching the Kushum horse practically does not differ from the Kazakh native horse [13].

Kushum stallions - good improvers of local horses in conditions of year-round herd ranching. Live weight of stallions - 400-410 kg, of mares - 350-360 kg. Use of the Kushum stallions allows to increase live weight of offspring from local mares already in the first generation on the average by 30-40 kg. Index of fertility - 78-85 foals per 100 mares, milking capacity of mares at the 2nd-3rd month of lactation - 14-22 liter/day [13].

Figure 3: Horses of the Kushum breed.

Mugalzhar breed

This breed has exclusive value for animal husbandry at year-round pasture-snowfield ranching [27]. The breed is created on the basis of perfection of the Kazakh native horses of the Dzhabe type and simple reproductive crossing of local mares of various regions with Dzhabe stallions and breeding of horses, meeting requirements of desirable types [27].

Specialists underline that this is the first-ever breed of a meat-and-milk direction of productivity, created on the basis of an unspecialized intra-breed type (Dzhabe) without addition of blood of stud farm breeds [13]. At the same time authors of this breed managed to increase live weight of stallions in comparison with initial horses by 100-120 kg, and mares by 80-100 kg without essential change of technologies of breeding, and a level of selection-breeding work has been raised to stud farm positions [13].

Analysis of exterior features of herd horses has demonstrated that they have high enough indices of massiveness – 142.6-158.5, that characterizes them as meat animals [13].

The breed structure consists of three intra-breed types - Embinsky, Kulandinsky, Sary-Arkinsky (and also since 2009 - Kozhamberdinsky), six lines and 55 families. Live weight of stallions - up to 560 kg, mares -

up to 520 kg, useful weight - 55-60%, successful fertility - 80-90%, milking capacity of mares reaches 2000 liters. Scientists have studied more than semi-centennial history of creation of the Mugalzhar breed [29].

Figure 4: The Kulandinsky intra-breed type of the Mugalzhar breed.

They underline those methods of its creation in different regions basically had no distinctions. Due to such work breeders provided quite sufficient genetic variety of the whole line of the breed. It is approbated in 1998 as a breed of horses of a meat-and-milk direction. Stallions of the Mugalzhar breed have proved themselves as improvers of local herd horses of a productive direction in the most various environment (from Priaral deserts to high mountains of the Eastern Kazakhstan) [13].

The Kostanay Breed

The development of the Kostanay breed took place across the steppes of western Kazakhstan, primarily within the confines of collective and state farms, with the core breeding efforts centralized at the Kostanay and Maikulski studs. This breed's evolution spanned from 1887, marking the establishment of the Turgai state-owned stud, through to its official recognition in 1951, with significant milestones including the founding of the Kostanay stud in 1888 and the Orenburg in 1890. Initially, attempts at crossbreeding native Kazakh steppe horses with breeds such as the Don, Stralets, Astrakhan (improved Kalmyk), and halfbred Thoroughbred stallions faced challenges. Success in hybrid vigor was achieved only after establishing a robust foundation of local broodmares, enhanced through selective breeding and consistent creep-feeding, at the Kostanay stud. By the 1920s, concerted efforts to cultivate a new breed commenced, continuing into the 1930s with dual management strategies. One approach emphasized stable housing and pasture grazing, supplemented by generous hay and concentrate feeding, manual mating, and early weaning of foals. The alternative strategy promoted enhanced taboon (herd) management, allowing for year-round grazing, shelter during adverse weather

conditions, unassisted mating, and supplementary feed of hay and concentrates [30].

Figure 5: The Kostanay breed.

The breeding work was directed at developing simultaneously two types - saddle and steppe. The saddle type included horses with a high proportion of Thoroughbred blood, while the steppe type consisted of Thoroughbred-Don-Kazakh. All saddlers were put to speed tests at the hippodrome. The Kostanay breed is found in Kostanay region and in southern Kazakhstan [31].

The Kostanay breed represents a substantial equine, blending superior qualities of a saddle horse with the inherent characteristics of the steppe heritage. Characterized by its anatomical structure, the Kostanay features include a straight, medium-sized head, wide jaws, and a poll that ranges from medium to short. The neck is straight, medium-long, and set low, complemented by wide, well-muscled, and medium-high withers. The back is straight, wide, and short, leading to a flat, solid, and muscular loin. The croup is medium-long, occasionally short, but well-rounded, with long and high-set shoulders, a wide and deep chest, and correctly positioned legs with well-developed joints and hard hooves, alongside strong tendons and ligaments, culminating in a robust and resilient build. Adapted to the continental climate, the Kostanay exhibits remarkable fitness. Stallions measure an average height at withers of 154.9 cm, oblique body length of 153.6 cm, chest girth of 180.5 cm, and cannon bone girth of 20.3 cm; mares present slightly different dimensions. The breed's coat can be bay, chestnut, reddish-grey, or brown [32].

Genetic Studies of the Kazakh native horse, breeds and types

The study of genetic polymorphism of horse breeds is of great importance for maintaining diversity in populations, improving breeding work and determining their origin. Of particular importance is the study of native horse breeds that have rare alleles in their genome and are hardy and well adapted to environmental conditions. One of the most effective approaches to assessing the genetic diversity of populations is the use of molecular DNA markers. The polymorphism of molecular genetic markers, revealed by the spectra of amplification products of DNA fragments using both dinucleotide and trinucleotide primers, is informative for assessing genetic differences that are formed not only between different breeds of farm animals, but also between types within a breed [17-19]. Analysis of mtDNA sequences allows to determine the origin and genetic similarity of breeds on the maternal line [33].

It should be noted that high-density single nucleotide polymorphism (SNP) arrays based on whole genome sequencing provide extensive information on variation across the genome of species of interest. Therefore, they are increasingly being used in the fields of origin and evolution studies [34].

The first analysis of the population structure and genetic diversity of the Kazakh native horse in Kazakhstan and China based on mitochondrial DNA was performed by Gemingguilli *et al.* (2016) [35]. Molecular genetic analysis was performed using the D-loop, cytochrome b gene and the DNA fragment containing the genes for the third subunit of cytochrome oxidase (COX3), the transfer RNA coding for the amino acid glycine (tRNA-Gly) and the third subunit of dehydrogenase (ND3). The aim of the work was to study the genetic structure between the populations of the two countries. As a result, it was found that domestic horse populations from Kazakhstan overlap with those from China, indicating low genetic distances (~1%) and a common ancestor (MCRA - most common recent ancestor).

Beyshova *et al.* [36] studied the genetic diversity of the main lineages of the Kostanay horse breed (Neon, Fort, Beaver, Windbreak, and Zeus) using microsatellite DNA. According to the study, the main lineages of Kostanay horse breed differ significantly by the presence and frequency of alleles of microsatellite loci, as each lineage has its own genetic structure with 17 microsatellite DNA loci. In addition, a lack of heterozygotes was found in the Neon and Windbreak lines, implying a frequent occurrence of inbreeding in these lines.

The polymorphism of microsatellite DNA of the Mugalzhar horse breed of the Kozhamberdinsky type was described in an article by Sydykov and Orazymbetova [37]. The results of the analysis showed that the number and frequency of occurrence of alleles for all markers in the Kozhamberdinsky type horse indicate a high level of genetic diversity. The similarity of the levels of expected and observed heterozygosity

in the studied population indicates random crosses in the herd.

In 2020, Kargayeva *et al*. [38] used STR markers to describe the population genetic structure of Kazakh native horses of Adai type. The analysis of the studied parameters of the population genetic structure of the Adai horse type confirmed the presence of intrapopulation differentiation of the animals in the conditions of the Mangyshlak Peninsula.

Researchers Nguyen *et al*. [39] identified genetic traits of the Kushum breed by studying haplotypes of mitochondrial DNA (mtDNA) and single nucleotide polymorphisms on the Y-chromosome, as well as genotypes of five functional genes associated with coat color, body composition, and locomotion traits. As a result, the scientists found 10 mtDNA haplotypes belonging to 8 of the 17 major haplogroups of equine mtDNA, indicating a unique haplotype composition with high genetic diversity. They also found two Y-chromosomal haplotypes in Kushum horses that are likely descended from Trotter and/or Don breeds.

Liu *et al*. [40] conducted a pilot study on 13 single nucleotide polymorphisms (SNPs) within five genes in Kazakh native horses using Kompetitive Allele Specific PCR (KASP™). An association study was performed for 6/13 polymorphic SNPs with average daily milk production in 60 Kazakh mares. The results showed that only two SNPs rs114262445 (NUMB), rs1136347938 (CA8) of the 6 polymorphic markers were significantly associated with milk production in Kazakh native horses. These results indicate the potential of using SNPs for the NUMB and CA8 genes as candidate genes for selection and farm production outputs.

Kassymbekova *et al*. [41] conducted a study of SNP polymorphisms at the loci of the LCORL, PRKAG3, and B3GALNT2 genes in horses of local breeds of the Kazakh Dzhabe type population. The first two DNA markers are associated with meat productivity and fertility of studs, and the third polymorphism is associated with a genetic defect (hydrocephalus). According to the results of genotyping in experimental animals, a high level of homozygosity for the loci of the LCORL and PRKAG3 genes was determined. No heterozygous carriers of the deleterious mutation B3GALNT2 were found in horses of the local breed by PCR-RFLP analysis. Autors recommend that, in the SNP perspective, the BIEC2-808543 polymorphisms in the LCORL gene and AAWR_02017454: g.121684T>C in the coding part of the PRKAG3 gene be used as a DNA marker of meat and reproductive function in horses.

The study of the genealogical structure of the herd makes it possible to prevent negative genetic processes in the local population of the breed by rational organization of the breeding processes in the breeding farms. Highly informative DNA markers are reliable tools for the analysis of genome architecture and gene polymorphism in animals, providing the possibility of selective intervention in the process of breeding. However, to date, Kazakh native horse breeds have been poorly studied at the molecular level, so further research remains relevant.

Conclusion

Currently, meat and dairy horse breeding in the Republic is mainly developed due to the breeding of Kazakh native horses of the Dzhabe type. The role of Kazakh native horses such as meat and dairy animals is exceptionally great. To improve the productive qualities of local herd horses, Kazakh native horse Dzhabe type horses are used along with the Kushum and Mugalzhar breeds.

The Kazakh native horse Dzhabe type is currently in need of radical improvement: increase in body size, live weight and working ability. At the same time, it is important to maintain its high adaptability to herding, as this form of horse breeding is the most profitable for the steppe, desert, semi-desert and mountain areas. Being a national treasure of our country, one of the most urgent tasks of Kazakh scientists is to preserve the gene pool of Kazakh native horses, which possess valuable biological and economically useful characteristics.

Increasing the genetic potential of productivity of local Kazakh native horses is mainly carried out through the use of proven methods and techniques of breeding, breeding new types and lines with high meat and dairy productivity. Kazakhstan's horse breeding needs to focus on the genetic resources of created high-value genotypes of horse breeds adapted to the specific natural and climatic zones (steppe and semi-steppe) of Kazakhstan with year-round pasture maintenance.

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Author Contributions

D. Kabylbekova was responsible for editing of the manuscript and for data collection.
T. Sh. Assanbayev was responsible for data analysis and manuscript editing.
Sh.N. Kassymbekova was responsible for the original idea, for the visual materials of this study and for funding management.

J. Kantanen was responsible for cleaning-up the manuscript after all the edits, for the additional data collection and for writing it in the first place.

Conflict of Interest

The authors declare that there is no conflict of interest.

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