Rocz. Nauk. Zoot., Vol. 52, no. 1 (2025): 61–70 *DOI: 10.58146/dzv4-n837*

MILK PRODUCTIVITY OF KAZAKH MARE TYPES JABE AND NOVOALTAY-KAZAKH IN THE STEPPE ZONE OF THE NORTH-EAST OF KAZAKHSTAN

[1]Tlekbol Sungatovich Sharapatov, [1]Tolegen Shonaevich Assanbayev, [2]Saukymbek Kauysovich Shauyenov, [3]Monika Bugno-Poniewierska, [3]Magdalena Pieszka

[1]Department of Zootechnology and Veterinary Medicine, NJSC Toraighyrov University, 140008, Pavlodar, Lomov Street 64, Kazakhstan
[2]Department of Technology for the Production and Processing of Livestock Products, NJSC S. Seifulin Kazakh Agrotechnical Research University, Zhengis Ave 62, Astana 010000, Kazakhstan
[3]Agricultural University in Krakow, Al. Mickiewicza 24/28, 30-059 Kraków, Poland

ORCID
Tlekbol Sungatovich Sharapatov 0000-0002-5177-4001
Tolegen Shonaevich Assanbayev 0000-0003-1096-7410
Saukymbek Kauysovich Shauyenov 0000-0003-2259-7111
Monika Bugno-Poniewierska 0000-0001-7537-6641
Magdalena Pieszka 0000-0002-5810-2312

Funding Information: The authors have not received any financial support or funding for this study.

Abstract

The article gives some indicators of milk productivity of Kazakh mare type Jabe (KJ) and Novoaltay-Kazakh (NA ×KJ) crossbreeds of the first generation in conditions of herd maintenance in the steppe area of Kazakhstan. To determine the milk productivity of the horses 2 experimental groups with a total of 30 mares, 15 heads in each group, were formed. The studied animals were divided on the principle of pairs of analogues in the section of the full age groups from 5 to 11 years. As a result of the studies of dairy productivity, Kazakh mares of the Jabe type had an average 1444.8 liters per 105-day lactation, and reliably inferior to the Novoaltay-Kazakh crossbreeds of 1932 liters. According to studies of actual milk yield, mares of different genotypes and ages in the test groups had the highest milk content at the age of 7 years. The results of research on the chemical composition of the milk of mares of different genotypes in the lactation months varied. Thus, the fat content of Kazakh mares of the Jabe type in the months of lactation averaged 1.82% in June, 1.77% in July, 1.89% in August, and 1.92% in September, and in Novoaltay-Kazakh crossbred mares: 1.75, 1.72, 1.85 and 1.88%, respectively. The protein content in the milk of Kazakh thoroughbred of the Jabe type averaged 2.18% in June, 2.15% in July, 2.22% in August, and 2.27% in September, and for Novoaltay-Kazakh crossbred mares it was 2.12, 2.09, 2.15 and 2.19%, respectively.

Keywords: mare milk, Jabe and Novoaltay-Kazakh mares, milk yield, milk productivity

Introduction

Kazakhstan is a country with a huge potential for the development of horse breeding. In this country horses graze all year round on pastures, so it is the most economical and affordable way to produce meat and milk horses (Nurmakhanbetov et al., 2022). Mare's milk is the most important source of nourishment for foals in the first months of life and also for population in Central Asia (Mongolia, Kazakhstan, Tajikistan, Kyrgyzstan), where lactic acid drinks called koumiss are traditionally produced by fermentation (Pietrzak-Fiećko et al., 2013). Fresh milk tastes sweet. The main components of milk are lactose, proteins, fats, vitamins, enzymes, minerals (Uzakbaev et al., 2013).

The increased interest in the development of dairy horse breeding is due to the fact that horses, being the most unpretentious animals, are able to use natural steppe, mountain and other pastures that are difficult for other farm animals to access. At the same time, the demand for koumiss, which has not only dietary and nutritional, but also antibiotic and healing properties, is constantly increasing (Iskhan et al., 2019a, b). In this regard, fermented mare milk is well known in ethnomedicine and represents an important traditional dietary ingredient for Asiatic populations of steppes, with strong cultural and environmental roots (Montanari et al., 1996; Outram et al., 2009; Langlois, 2011). Results from a survey on the consumption of koumiss, that is, raw horse milk fermented according to the pastoral nomad tradition, report an average daily intake per capita ranging from 3 to 9.7 l (Ishii et al., 2014).

During the last decade, the consumption of horse milk has become more popular in Western European and Northern American countries (Claeys et al., 2014), especially among people suffering from bowel problems, cows' milk intolerance (Salimei and Fantuz, 2012), and skin diseases such as eczema and psoriasis. Skin rashes from these diseases are thought to dissipate as an effect of consuming horse milk. However, these effects have not been thoroughly investigated and the mode of action is not clear. Interest has increased in the use of mare milk for human nutrition in the past several years, especially in France and Germany (Doreau and Martin Rosset, 2011). In Italy, mare milk has been considered as a possible substitute for cow milk as formula for allergic children (Businco et al., 2000; Curadi et al., 2001). Mare milk also has been used for the treatment of certain human pathologies such as hepatitis, chronic ulcer, and tuberculosis (Nassal and Rembalski, 1980; Solaroli et al., 1993). This premise of therapeutic value and hypoallergenicity of mare milk to humans is probably based on the fact that horse milk composition is significantly different from that of bovine milk (Csapó et al., 1995; Kucukcetin et al., 2003; Malacarne et al., 2002; Marconi and Panfili, 1998) and it is often considered to be close to that of human milk (Pieszka et al., 2016), with particular reference to its low nitrogen content, its low casein-to-whey protein ratio, and its high content of lactose (Bonomi et al., 1994).

The current state of the industry in Kazakhstan requires an increase in the number of horses and an increase in their productivity, both by improving the organization of the herd system and through the use of interbreeding that provide for the maximum possible preservation of adaptive quality of herd horses (Akimbekov et al., 2023; Naimanov et al., 2018; Akimbekov et al., 2017). It has been established that the riding Kazakh crossbreeds in body weight (403–410 kg) outperform the local Kazakh horses (395 kg). It was established that in riding Kazakh crossbred mares the daily milk yield for 2–4 months of lactation is 7–10 liters (Iskhan et al., 2019a, b). Assanbayev et al. (2019) emphasize the importance of this breed for improving the productive qualities of local horses in the conditions of North-East Kazakhstan horse breeding as the most optimal combination of the blood of the Soviet, Russian and Lithuanian draft breeds, having high milk production, excellent adaptive qualities to the year-round pasture content (Assanbayev et al., 2019).

The aim of the research work was to determine some indicators of dairy productivity of the thoroughbred Kazakh Jabe type and Novoaltay-Kazakh crossbreeds of the first generation under conditions of pasture in the steppe district of the Republic of Kazakhstan. The research hypothesis is that crossbred mares produce more milk than purebred mares.

Material and methods

The research was carried out in the farm KH Zhana-Aul of the Pavlodar region of the Republic of Kazakhstan. The object of the study were mares of the Kazakh Jabe type (KJ) and Novoaltay-Kazakh crossbred mares of the first generation (NA × KJ). The farm practices year-round grazing of horses. To determine the milk productivity of mares of different genotypes, two experimental groups of 15 animals per group were formed with ages from 5 to 11 years.

Milking of mares was carried out 5 times a day with the electric milking machine Model DDU-2 (Melasty, Turkey), with 2 hours' break between milkings. This milking rate is related to anatomical and physiological features of udder structure and milk production in mares. The actual yield of mares was determined monthly during the period of lactation by the method of control rates twice a month on two consecutive days. Daily yield of mares is calculated according to Saigin's formula, taking into account the milk sucked at night by the foal (Saigin, 1967):

$$\text{Ус} = \frac{\text{Уф} \times 24}{t}$$

where: *Yc* – daily milk yield, kg; *Yф* – actual daily milk yield, kg; *24* – number of hours per day; *t* – time of mare in milking in hours.

The coefficient of milk production per 100 kg of live weight was determined by the formula:

$$Milk\ coefficient = \frac{\text{У}}{\text{Ж}} \times 100$$

where *У* – yield per lactation, liter; *Ж* – living mass of mare, kg.

The chemical composition was determined on the device Lactan 1-4M model 700 (SibAgroPribor, Russia 2013, No 007150207), in the Testing Laboratory of the Research Institute of Agro-Innovation and Biotechnology at the Toraighyrov University. Statistical analysis of the received digital data was carried out using the software PS Solution NO 3830/01/2019.

Results

Dairy productivity of the mares of Kazakh Jabe and Novoaltay-Kazakh crossbreeds was determined monthly, during three and a half months of lactation (105 days). According to our research, the two test groups have different milk productivity indicators. The crossbred mares had higher milk production, the data are presented in Table 1.

Table 1. Dairy productivity of mares of different genotypes

Indicator	Horse genotype	
	Kazakh Jabe type	Novoaltay-Kazakh crossbreeds
	$X \pm m_x$	$X \pm m_x$
Actual milk per day, l	5.73±0.19	7.66±0.4***
Daily milk yield, l	13.76±0.45	18.4±0.9
Milk yield for 105 days of lactation, l	1444.8±47.4	1932±91.5
Milk coefficient, l	333.3±12.63	374.9±13.50
Protein, %	2.21±0.01	2.14±0.01**
Fat, %	1.85±0.01	1.80±0.02*

Note: * P>0.95; ** P>0.99; *** P>0.999.

On average, the daily yield for 105 days of lactation was 1932 l for the Novoaltay-Kazakh crossbred mares (NA × KJ) and 1444.8 l for the thoroughbred mares of the Kazakh Jabe. In this way, groups of crossbred mares (NA × KJ) have a milk yield higher by 487.2 l or 25.2%. The actual yield per day varied from 5.73 l to 7.66 l, and the daily yield from 13.76 l to 18.4 l. It has been established that the milk coefficient, that is, the production of milk per 100 kg of live mass, in crossbred mares was higher by 41.6 l or 11.09% than in mares of Kazakh Jabe type.

The chemical composition of mare's milk differed slightly between the genotypes of protein and fat. Thus, the average mares of the Kazakh Jabe type had a slight superiority in protein and fat (2.21–1.85%), compared with the crossbred mares (NA × KJ) (2.14–1.80%). However, the total amount of milk protein and fat for 105 days of lactation in crossbred mares were higher (34.73–41.33 kg) than indicators of Kazakh Jabe type (26.70–31.86 kg), that is, superior in the total amount of milk protein (9.47 kg) and fat (8.03).

Our results for actual milk yield of mares of different genotypes, depending on age, are presented in Chart 1.

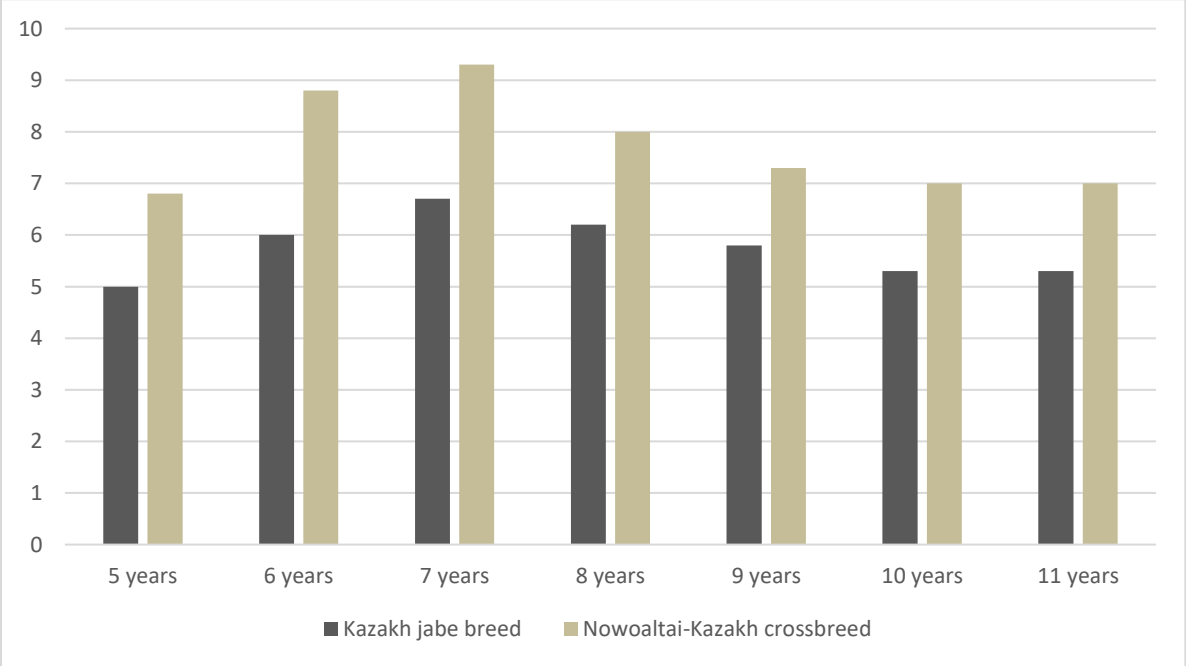

Chart 1. Milk yield (l) of studied mares according to their age

Chart 1 shows that in both test groups, 7-year-old mares had the highest milk production and 5-year-old mares had the lowest milk production, which we attribute to the fact that steppe horses mature late and have not fully realized their productive potential. It should be noted that

the crossbred mares at all ages were superior in milk production over the Kazakh Jabe type mares. The fluctuations in the fat of the mares of the Kazakh breed for six months of lactation were in the range of 1.1–1.9%, while of the Arab-Kazakh and English-Kazakh hybrids, 1.31–2.0% and 1.4–2.2%, respectively. That is, the bloodline of horses does not have a significant impact on the indicators of the chemical composition of the mares' milk (Iskhan et al., 2019a, b).

The fat content of mare's milk ranges from 1.1 to 2.5% depending on the breed of the horse, the lactation period of the feed composition and especially the milk yield. In our study, the average fat and protein content of mares in different genotypes was slightly different depending on the months of lactation (Table 2).

Table 2. Mare's milk fat content (%) by months of lactation

Months of lactation	Horse genotype					
	Kazakh Jabe type, n=15			Novoaltay-Kazakh crossbreeds, n=15		
	$X \pm m_x$	δ	C_V, %	$X \pm m_x$	δ	C_V, %
June, II	1.82±0.01	0.04	2.08	1.75±0.02	0.08	4.49
July, III	1.77±0.01	0.04	2.52	1.72±0.02	0.08	4.70
August, IV	1.89±0.01	0.05	2.90	1.85±0.01	0.05	2.75
September, V	1.92±0.01	0.05	2.74	1.88±0.01	0.06	2.99

Table 2 shows that the fat content of Kazakh mares of the Jabe type in all lactation months is slightly higher than that of mares (NA × KJ). In the second month of lactation, Kazakh type Jabe (KJ) mares had a 1.82% fat content compared to 1.75% in the milk of crossbreed (NA × KJ) mares (superiority of 0.07%) in the third month of lactation. Both groups had a decrease in milk fat, 1.77% in mares (KJ) and 1.72% in crossbred mares (superiority of 0.05%), then from the fourth month of lactation there is a gradual increase in milk fatness, 1.89% in mares (KJ) and 1.85% in crossbred mares (superiority of 0.04%) and in the fifth month lactation it reached 1.92% in purebred mares (KJ) and 1.88% in mares of crossbreeds (NA × KJ) (superiority of 0.04%). These results revealed the following pattern: with the increase in milk production there was a decrease in the mass fat ratio in milk. It should be noted that the results show very good fat levels of tested mares' milk. Of the components of milk are its proteins, which contain all the essential amino acids. The average protein in mare's milk varied slightly from month to month, as shown in Table 3.

Table 3. Mare's milk protein content (%) by months of lactation.

Months of lactation	Horse genotype					
	Kazakh Jabe type, n=15			Novoaltay-Kazakh crossbreeds, n=15		
	$X \pm m_x$	δ	C_V, %	$X \pm m_x$	δ	C_V, %
June, II	2.18±0.02	0.06	2.79	2.12±0.01	0.05	2.36
July, III	2.15±0.01	0.05	2.19	2.09±0.01	0.04	2.12
August, IV	2.22±0.01	0.05	2.46	2.15±0.01	0.04	2.06
September, V	2.27±0.01	0.05	2.11	2.19±0.02	0.07	3.14

The protein content in the milk of thoroughbred Kazakh Jabe type averaged 2.18% in June, 2.15% in July, 2.22% in August and 2.27% in September, compared to 2.12, 2.09, 2.15 and 2.19% for crossbred mares (NA × KJ), respectively. In the first two months of lactation, mares in test groups had the lowest total protein levels (KJ) of 2.18–2.15% and (NA × KJ) of 2.12–2.09% and total proteins in both groups increased from the third month. So the protein levels in the milk for August-September months of lactation were 2.22–2.27% in mares (KJ) and 2.15–2.19% in crossbred mares (NA × KJ)

The right choice of breeds of horses for crossing is one of the important methods in increasing meat and dairy productivity and in the further creation of the desired dairy type of the Kazakh horse breed. However, the desired productivity of mares and the creation of a high-

yield group can be achieved by selecting milky mares by udder and nipple shape. At the same time, we selected the mares according to the structure and shape of the udder and nipples.

For this purpose, in order to study the relationship of the ground and udder shape with the milk yield of the mare, the following measurements were removed: depth, girth, udder length, nipple length, width and distance between them. All the measurements were taken with a measuring tape. Analysis of the examined udders and nipples showed the possibility of selection of dairy mares on these grounds. Based on the experiment, it was found that mare's milk production is related to length, udder circumference and udder and nipple width. It was found that mares with a long (bath-like) udder, for 180-day lactation, gave 1100 kg of milk, which was 52.0% more than for mares with an average length, and 77.0% more than with a short (rounded) form. The milk yield for lactation of mares with a long udder is higher compared to those with an average length and a short udder, by 48.2 and 76.5%, respectively. The lactation period was also longer. The results of our research are shown in the following Table 4.

Table 4. Milk content of mares according to their udder and nipple structure

Name	Duration of lactation, days	Milk yield, kg
By udder length:		
1. long udder	233.0±15.66	1101.3±258.30
2. medium length udder	200.3±8.97	720.0±69.4
3. short udder length	186.3±12.35	617.4±186.90
By udder depth:		
1. deep udder	218.0±19.10	745.4±166.71
2. mean udder depth	193.6±7.90	757.5±81.92
3. fine udder depth	208.0±28.04	640.0±200.84
By circumference (volume) of udder:		
1. bulk udder	226.0±34.52	1006.8±366.78
2. average udder volume	200.5±8.91	739.5±80.15
3. small udder	183.0±21.47	765.3±186.05
By nipple length:		
1. long nipple	185.5±16.56	603.0±189.56
2. medium-length nipple	199.6±8.00	752.2±79.20
3. short nipple	197.8±20.02	636.3±206.00
By nipple width:		
1. wide nipple	181.0±33.54	1115.1±339.00
2. medium nipple width	196.4±7.63	696.5±69.67
3. narrow nipple width	218.0±17.00	675.0±168.13
By distance between nipples:		
1. long distance	193.0±10.00	771.0±378.15
2. medium distance	201.3±8.00	744.4±77.72
3. small distance	197.0±21.69	750.9±160.70

Mares with an average udder depth surpass mares with deep udders by 1.5% in milk productivity, and small udders by 17.9%, but are inferior in lactation duration. High milk is characteristic of mares with a volume udder, that is, large in girth, they have a longer lactation. During 180 days of lactation, they exceed the milk content of animals with an average udder girth by 36.1%, and small udders by 31.5% ($P<0.05$). Mares with wide nipples had an advantage over animals of other groups, exceeding their milk yield for 180 days of lactation by 59.7 and 64.7% ($P<0.05$), but were characterized by relatively short lactation.

According to the results of the study, it was found that the desired shape of the udder and nipples of mares can be considered an udder that has a sufficient length (19–21 cm), an average depth (9–11 cm), a large girth (29–31 cm), not long (3–4 cm), wide (6.3–7 cm), and widely spaced (8 cm) nipples.

As a result of the study, it was found that the selection of the most dairy crossbred mares into a separate herd, as well as the selection according to the shape of their udders and nipples, allows us to predict the level of dairy productivity and allocate animals of the desired type to a group, by setting a standard for dairy mares in the breeding region, followed by the creation of a specialized dairy type of the Kazakh horse breed.

Discussion

Mare's milk has relatively low levels of protein and ash, but a higher lactose content compared to the milk of traditional dairy animals, such as cows, sheep, and goats (Pulina and Nudda, 2002). According to recent modeling studies on mare milk components during lactation, fat and protein show a decreasing trend while an increasing trend is reported for lactose (Santos and Silvestre, 2008; Centoducati et al., 2012). The horse breeding industry needs to enhance breeding qualities by optimizing pasture use and implementing interbreeding. This approach will accelerate the productivity of horses (Assanbayev et al., 2016; Kabylbekova et al., 2024). To advance productive horse breeding, studies were conducted on Kazakh mares of the Jabe type and their crosses with Novoaltay stallions. Targeted breeding can enhance meat productivity up to 30%, as demonstrated by successful examples from the Altay Territory. Foals can achieve daily weight gains of up to 2 kg (Ramazanov et al., 2013).

Crossing Kazakh mares with Novoaltay stallions in Kazakhstan significantly enhances the productive qualities of local horses, thanks to increased genetic diversity and strong adaptive traits (Sharapatov et al., 2023). Studies have shown that during the peak of lactation, crossbred mares outperform purebred mares in milk yield by 41–42.5%. It is recommended to pursue crossbreeding to develop a high-yielding herd (Sharapatov et al., 2022). It was also found that Upper Kazakh crossbreeds surpass local Kazakh horses, which weigh around 395 kg, with live weights ranging from 403 to 410 kg. Additionally, the daily milk yield during the 2–4 months of lactation for mares of the riding Kazakh crossbreed is between 7 and 10 liters (Iskhan et al., 2019a, b).

Crossbred mares from the Russian Heavy Draft breed significantly outperformed purebred Transbaikal and Yakut-Transbaikal horses in milk productivity, with increases of 11.8% ($P<0.01$) and 9.0% ($P<0.05$), respectively. They also surpassed them in live weight by 10.4% and 8.9% ($P<0.001$), respectively (Kalashnikov et al., 2020).

The Heavy Draft-Kazakh crossbreeds have an average daily milk yield of 6.9±0.7 kg (Cv = 27.2%), while the Kazakh horses yield 5.3±0.4 kg (Cv = 18.7%), and the Don-Kazakh crossbreeds produce 5.4±0.3 kg (Cv = 22.6%). It was established that the Kazakh horses produce 883.0±55.2 kg of milk with an average live weight of 450.2±9.6 kg, while the Heavy Draft-Kazakh crossbreeds yield 568.0±15.4 kg and 1129.1±56.9 kg, and the Don-Kazakh crossbreeds produce 530.2±11.8 kg and 904.1±60.0 kg. The dry matter content in the milk is significantly higher in Heavy Draft-Kazakh crossbreeds at 128.4±6.0 kg, compared to Kazakh horses at 97.1±5.2 kg and Don-Kazakh crossbreeds at 120.5±3.8 kg (Zhumadilova and Iskhan, 2019). In the crossbreeds of riding breeds with local Kazakh horses, the milk yield of the mares during 105 days of lactation ranged from 7 to 10 liters (Kargayeva et al., 2020). For four months of lactation, 1051 liters of commercial milk were produced from mares with cup-shaped udder, while 823.6 liters – with round-shaped udder (Baimukanov et al., 2021).

The content of fat, protein, lactose and ash was 1.51, 2.35, 6.05 and 0.6% for mares of the Kazakh breed, 1.35, 2.23, 6.13 and 0.5% for the Kazakh Jabe horse, and 1.29, 2.27, 6.2 and 0.6% for the Kazakh horse of the Adai offspring (Baimukanov et al., 2023). It is difficult to distinguish the influence of breed on the chemical composition of milk compared to the effects of feeding technology or housing conditions for horses (Coenen et al., 2011).

Milk production in mares occurs at a high intensity, averaging 0.44 kg/min, and features two peaks: the first is the release of cisternal milk (1.5 g of fat per kg of milk), followed by the release of alveolar milk (5–11 g of fat per kg of milk) due to the influence of endogenous oxytocin on the myoepithelial cells (Bat-Oyun et al., 2015).

Mare's milk contains higher levels of easily digestible albumins and globulins compared to cow's milk. Additionally, it surpasses cow's milk in terms of peptones and amino acids, although it has lower levels of fats and proteins. The lactose content in mare's milk is 20% higher than in cow milk, and it contains 5–6 times more vitamins, particularly vitamin C, compared to cattle (Akimbekov et al., 2018).

Conclusions

Thus, one of the main ways to increase the milk production of local horses in horse herding is crossbreeding. For this reason, we recommend that the Novoaltay-Kazakh breed be used as the best possible combination of the blood of the Soviet, Russian and Lithuanian draft breeds with excellent adaptability qualities for year-round high milk production pasture. This direction in the future suggests that crossing between Jabe and Novoaltay types of Kazakh horses will result in an increase in the average dairy production to 2300–2500 liters for lactation, which in the future creates the prerequisites for the creation of new specialized dairy lines and types of Kazakh horse breed.

Acknowledgements
I would like to express my gratitude for the advice when writing the article to Prof. dr hab. Monika Bugno-Poniewierska and Dr Magdalena Pieszka from the Agricultural University in Krakow, Poland.

References

Akimbekov A.R., Baymukanov D.A., Yuldashbaev Yu. A., Iskhan K.Zh. (2017). Productive qualities of the Seleti factory-type Kazakh horses of the Jabe. Bull. Nat. Acad. Sci. Rep. of Kazakhstan., 367: 100–110.

Akimbekov A.R., Baymukanov D.A., Iskhan K.Z. (2018). Milk productivity and composition of mares of different genotypes. Proceedings of the National Academy of Sciences of the Republic of Kazakhstan, 2: 172–180.

Akimbekov A.R., Uskenov R.B., Iskhan K.Zh., Assanbayev T.Sh., Sharapatov T.S., Baimukanov D.A. (2023). Creation of smart farms in the herd horse breeding of Kazakhstan. J. Biol. Sci., 23:44–49.

Assanbayev T.Sh., Gromova T.V., Sharapatov T.S. (2016). The results of the Novoaltayskaya horse breed use in productive horse breeding of the North-Eastern part of Kazakhstan. Bull. Altai State Agr. Univ., 4: 143–149. https://www.asau.ru/files/vestnik/2016/4/143-149.pdf

Assanbayev T.Sh., Temirzhanova A.A., Ibraeva A.K., Shamshidin A.Sh., Bexeitov T.K., Ussenova L.M. (2019). The influence of Novoaltaysk breed of horses in the development of productive horse breeding in the North-East of Kazakhstan. AD ALTA: J. Interdisciplinary Research, l: 101–112.

Baimukanov D.A. (2021). Dairy productivity of Kazakh horse mares. International AgroScience Conference, IOP Conf. Series Earth and Environmental Science, 935: 012018.

Baimukanov A.D., Aubakirov K.A., Kargayeva M.T., Iskhan K.Z., Bekenov D.M., Yuldashbayev Y.A., Baimukanov D.A. (2023). Productivity of horse and camel breeds from the arid zone of the Republic of Kazakhstan. OnLine J. Biol. Sci., 23: 402–410.

Bat-Oyun T., Erdenetsetseg B., Shinoda M., Ozaki T. (2015). Who is making airag (fermented mare's milk)? A nationwide survey of traditional food in Mongolia. Nomadic People, 19: 7–29.

Bonomi F., Iametti S., Pagliarini E., Solaroli G. (1994). Thermal sensitivity of mares' milk proteins. J. Dairy Res., 61: 419–22.

Businco L., Giampietro P.G., Lucenti P. (2000). Allergenicity of mare's milk in children with cow's milk allergy. J. Allergy and Clinical Immun., 105: 1031–1034.

Centoducati P., Maggiolino A., De Palo P., Tateo A. (2012). Application of Wood's model to lactation curve of Italian Heavy Draft horse mares. J. Dairy Sci., 95: 5770–5775.

Claeys W.L., Verraes C., Cardoen S. (2014). Consumption of raw or heated milk from different species: an evaluation of the nutritional and potential health benefits. Food Control, 42: 188–201.

Coenen M., Kienzle E., Vervuert I. (2011). Recent German developments in the formulation of energy and nutrient requirements in horses and the resulting feeding recommendations. J. Equine Vet. Sci., 31: 219–229.

Csapó, J., Stefler J., Martin T.G. (1995). Composition of mares' colostrums and milk. Fat content, fatty acid composition and vitamin content. Int. Dairy J., 5: 393–402.

Curadi M.C., Giampietro P.G., Lucenti P., Orlandi M. (2001). Use of mare milk in pediatric allergology. Proceedings of Associazione Scientifica di Produzione Animale XIV Congress, Firenze, Italy, June 12–15, 2001, pp. 647–649.

Ishii S., Hosino B., Komiyama H. (2014). Study on production and properties of kumiss of herders in Mongolian dry steppe. J. Arid Land Studies, 24: 195–197.

Iskhan K.Zh.,. Kalashnikov V.V, Akimbekov A.R., Mongush S.D., Demin V.A., Rzabayev T.S., Nesipbaeva1 A.K., Zhilkybaeva1 M.M., Zhikishev Y.K. (2019a). Zootechnic characteristics of modern populations of Mugalzhar horse breed. Bull. Nat. Acad. Sci. Rep. of Kazakhstan., 6 (382): 75–82

Iskhan K.Zh., Akimbekov A. R., Baimukanov A.D., Aubakirov Kh.A., Karynbayev A.K., Rzabayev T.S., Geminguli M., Dzhunusova R.Z., Apeev K.B. (2019b). Dairy productivity of the Kazakh horse mares and their cross breeds with roadsters. Bull. Nat. Acad. Sci. Rep. of Kazakhstan., 379: 22–35.

Kabylbekova D., Assanbayev T.S., Kassymbekova S., Kantanen J. (2024). Genetic studies and breed diversity of Kazakh native horses: A comprehensive review. Adv. Life Sci., 11: 18–27.

Kalashnikov R.V., Bazarov B.Z., Khamiruev T.N., Solbon D., Zigzyma B., Dondokov A. (2020). Milk productivity of mares of different genotypes. Horse Breeding and Equestrian Sports, 3: 35–36.

Kargayeva M.T., Baimukanov D.A., Nurbaev S.D., Baimukanov A.D., Alikhanov O., Yusupbayev Zh. (2020). Identification of Kazakh horses by microsatellite DNA using modern analytical methods. Sci. J. Westnik NAN RK., 4: 55–61.

Kucukcetin, A., Yaygin H., Hinrichs J., Kulozik U. (2003). Adaptation of bovine milk towards mares' milk composition by means of membrane technology for koumiss manufacture. Int. Dairy J., 13: 945–951.

Langlois B. (2011). The history, ethnology and social importance of mare's milk consumption in Central Asia. J. Life Sci., 5: 863–872.

Malacarne M., Martuzzi F., Summer A., Mariani P. (2002). Protein and fat composition of mare's milk: some nutritional remarks with reference to human and cow's milk. Int. Dairy J., 12: 869–877.

Marconi E., Panfili G. (1998). Chemical composition and nutritional properties of commercial products of mare milk powder. J. Food Compos. Anal., 11: 178–187.

Montanari G., Zambonelli C., Grazia L. (1996). *Saccharomyces unisporus* as the principal alcoholic fermentation microorganism of traditional kumiss. J. Dairy Res., 63: 327–331.
Naimanov D.K., Turabayev A.T., Bakhtybayev G.T., Seleuova L.A., Baitursynov-Kostanay A. (2018). Horse breeding. Kostanay State University, Russia, pp. 227–238.
Nassal J., Rembalski C. (1980). Hygienische Forderungen bei der Produktion von Stuten-Milch and Kumys. Arch. fur Lebensmittelhy, 31: 209–212.
Nurmakhanbetov D.M., Sydykov D.A., Baktybayev G.T. (2022). Dairy productivity of dairy mares on a model farm in different regions of Kazakhstan, Europe and the World: Science, Engineering and Technology: Materials of the VII International Scientific and Practical Conference. Volume I – Mersin, Turkey: Regional Academy of Management, pp. 106–114.
Outram A.K., Stear N.A., Bendrey R. (2009). The earliest horse harnessing and milking. Science, 323: 1332–1335.
Pietrzak-Fiećko R., Tomczyński R., Smoczyński S. (2013). Effect of lactation period on the fatty acid composition in mares' milk from different breeds. Arch. Anim. Breed., 56: 335–343.
Pieszka M., Łuszczyński J., Zamachowska M., Augustyn R., Długosz B., Hędrzak M. (2016) Is mare milk an appropriate food for people? – a review. Ann. Anim. Sci., 16: 33–51.
Predictive Solutions Computer Software for Statistical Analysis of Digital Data PS Solution NO 3830/01/2019.
Pulina G., Nudda A. (2002). Milk production, dairy sheep feeding and nutrition, Avenue Media, Bologna, Italy, pp. 11–27.
Ramazanov A.U. (2013). Prospects for the development of productive horse breeding in the conditions of the northern region of Kazakhstan. Horse breeding and camel breeding – traditional livestock industries of Kazakhstan: 4th International Scientific and Practical Conference, Kostanay, pp. 102–106.
Saigin I.A. (1967). Mare's milk, its use for the treatment of koumiss. Rosselkhoznadzor, p. 184.
Salimei E., Fantuz F. (2012). Equid milk for human consumption. Int. Dairy J., 24: 130–142.
Santos A.S., Silvestre A.M. (2008). A study of Lusitano mare lactation curve with Wood's model. J. Dairy Sci., 91: 760–766.
Sharapatov T., Assanbayev T., Shauyenov S., Aubakirov K., Iskhan K. (2023). Increasing the milk productivity of Kazakh Jabe horses. Brazilian J. Biol., 83: 1–7.
Sharapatov T.S., Assanbaev T.S., Shauyenov S.K., Ibraeva A. K., Smail A.S. (2022). Milk productivity of mares of different genotypes in conditions of herd maintenance. Bull. Sci. Kazakh Agrotechnical Univ., 1: 233–241
Solaroli G., Pagliarini E., Peri C. (1993). Compositional and nutritional quality of mare's milk. Italian J. Food Sci., 4: 323–333.
Uzakbaev K. A., Mamyrbaeva T. T. (2012). Mare's milk and kymyz: Academic and Medical Teaching Guide. Bishkek, Kyrgyzstan, pp. 134–142.
Zhumadilova A.S., Iskhan K.Z. (2019). Milk productivity of Kazakh horses and their crossbreeds. In: Financial, Economic, and Technological Issues in Regional Development: Proceedings of the International Scientific and Practical Conference for Young Researchers, Stavropol, 16–18.09.2019, pp. 96–99.

Accepted for printing: 1 IV 2025