
**FACTORS INFLUENCING MILK PRODUCTION
AND MILK QUALITY OF MARES**

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INTRODUCTION

In countries of developed economy and animal husbandry, in particular, the production of mares' milk on organic farms is one of the promising areas of animal husbandry. More than 30 million people in the world regularly consume mare's milk and products of its processing¹.

Mares' milk as a food product is traditionally produced in Asian countries: Northern China, Mongolia, Kazakhstan, Kyrgyzstan, Uzbekistan and others^{2, 3}. In some countries, mares' milk accounts for more than 8% of total milk production⁴. Traditionally, it is used for the production of fermented milk drinks (ayran, koumiss, etc.). In the context of a significant increase in demand for environmentally friendly products, the importance of horse breeding products, in particular mares' milk, is increasing, and therefore productive horse breeding is a competitive branch of animal husbandry⁵. At the same time, the consumption of mares' milk in recent decades has spread to the countries of the European Union: France, Belgium, Germany, the Netherlands, Norway, Austria, Hungary, Bulgaria. In European countries, the share of mares' milk in

¹ Doreau, M.; Martin-Rosset, W. Animals that produce dairy foods – horse. Encyclopedia of Dairy Sciences. 2nd ed.; Fuquay, J.W., Fox, P.F., McSweeney, P.L.H., Eds.; Elsevier Academy Press: London, UK. 2011. Vol. 1. P. 358–364. <https://doi.org/10.1016/B978-0-12-374407-4.00040-6>

² Blanco-Doval A., Azkargorta M., Iloro I., Beaskoetxea J., Elortza F., Barron L. J. R., Aldai N. Comparative proteomic analysis of the changes in mare milk associated with different lactation stages and management systems. Food Chemistry. 2024. Vol. 445. P. 138766. <https://doi.org/10.1016/j.foodchem.2024.138766>

³ Pieszka M., Łuszczynski J., Zamachowska M., Augustyn R., Długosz B., Hędrzak M. Is mare milk an appropriate food for people? review. *Ann. Anim. Sci.* 2016. Vol. 16(1). P. 33–51. <https://doi.org/10.1515/aoas-2015-0041>

⁴ Uniacke-Lowe, T.; Fox, P.F. Equid milk: Chemistry, Biochemistry and Processing. *In Food Biochemistry and Food Processing*. B.K. Simpson (Ed.). 2012. P. 491–530. <https://doi.org/10.1002/9781118308035.ch26>

⁵ Berdimurat N. Cost accounting in the horse breeding industry of Kazakhstan improving due to international standards. *Economic Annals XXI*. 2015. Vol. 150. Iss. 3–4(2). P. 75–78. <https://ea21journal.world/index.php/ea-v150-18/>

the total milk production is only 0.1%, which is about 1300 tons. Mares' milk has a high nutritional value and practically does not contain allergenic proteins, unlike cow's milk^{6, 7, 8, 9, 10}. This factor makes it possible to use mares' milk in baby and diet food^{11, 12}. The positive effects on the human intestine from the consumption of yogurt from mares' milk are known¹³. Mares' milk is used to make kefir, fermented milk products mixed with goat and sheep's milk,¹⁴ and even ice cream with high taste and dietary qualities¹⁵. Also, mares' milk is the basis for the production of pharmaceuticals and dietary supplements¹⁶.

Organoleptically, mares' milk is not similar to cow's, but it is similar to women's, it is more transparent, whiter and sweeter due to its higher lactose content (1.5 times higher than cow's), which ensures its taste appeal to babies¹⁷.

The high identity of the chemical composition of mares' milk to women's milk gives rise to its widespread use in baby food for feeding babies on artificial

⁶ Jastrzębska E., Wadas E., Daszkiewicz T., Pietrzak-Fiećko R. (2017). Nutritional Value and Health-Promoting Properties of Mare's Milk. Review. *Czech J. Anim. Sci.*; 62(12): 511–518. <https://doi.org/10.17221/61/2016-CJAS>

⁷ Businco L., Giampietro P.G., Lucenti P., Lucaroni F., Pini C., Di Felice G., Iacovacci P., Curadi C., Orlandi M. Allergenicity of mare's milk in children with cow's milk allergy. *J Allergy Clin Immunol.* 2000. Vol. 105. P. 1031–1034. <https://doi.org/10.1067/mai.2000.106377>

⁸ Centoducati P., Maggolino A., De Palo P., Tateo A. Application of Wood's model to lactation curve of Italian Draft horse mares. *J. Dairy Sci.* 2012. Vol. 95. P. 5770–5. <https://dx.doi.org/10.3168/jds.2012-5513>

⁹ Jastrzębska E., Wadas E., Daszkiewicz T., Pietrzak-Fiećko R. (2017). Nutritional Value and Health-Promoting Properties of Mare's Milk. Review. *Czech J. Anim. Sci.*; 62(12): 511–518. <https://doi.org/10.17221/61/2016-CJAS>

¹⁰ Romaniuk, K.; Majszyk-S'wia tek, M.; Kryszak, K.; Danielewicz, A.; Andraszek, K. Alternative use of mare milk. *Folia Pomer. Univ. Technol. Stetin.* 2019. Vol. 348. P. 121–130. <https://doi.org/10.21005/AAPZ2019.49.1.13>

¹¹ Ranadheera C. S., Naumovski N., Ajlouni S. Non-bovine milk products as emerging probiotic carriers: recent developments and innovations. *Curr. Opi. Food Sci.* 2018. Vol. 22. P. 109–114. <https://doi.org/10.1016/j.cofs.2018.02.010>

¹² Herber C., Bogler L., Subramanian S.V., Vollmer S. Association between milk consumption and child growth for children aged 6–59 months. *Sci Rep.* 2020. Vol. 10(1). P. 6730. <https://doi.org/10.1038/s41598-020-63647-8>

¹³ Kozhakhmetov S., Muhanbetganov N., Pernebek Z., Babenko D., Tarzhanova D., Uyzbaeva I. Effects of low lactose mare's milk yogurt consumption on gut microbiota function. *Funct. Foods Health Dis.* 2022. Vol. 12(8). P. 455–464. <https://doi.org/10.31989/ffhd.v12i8.981>

¹⁴ Cais-Sokolińska D., Worjtowski J., Pikul J. Rheological, texture and sensory properties of kefir from mare's milk and its mixtures with goat and sheep milk. *Mlječarstvo.* 2016. Vol. 66(4). P. 272–281. <https://doi.org/10.15567/mlječarstvo.2016.0403>

¹⁵ Akanova A., Kikebayev N., Shaiknova K., Seiitkazhy Z., Okuskhanova E. Nutritive and biological value of mare's milk ice cream. *Pak. J. Nutr.* 2017. Vol. 16. P. 457–462. <https://doi.org/10.3923/pjn.2017.457.462>

¹⁶ Stuparu A. A., Strugariu C. E., Oroian T. (2016). Pharmaceuticals and dietary supplements extracted from mare's milk. *Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca Anim. Sci. Biotechnol.* 2016. Vol. 73. P. 1–10. <https://doi.org/10.15835/buasuvmen-asb:11429>

¹⁷ Kunying Li, Yixin Yang, Qilong Li, Ran Chen, Liang Deng, Yiwei Zhang, Ning Jiang. Identification and comparison of milk fat globule membrane and whey proteins from Selle Français, Welsh pony, and Tieling Draft horse mare's milk. *Food Chemistry.* 2024. Vol. 437. Iss. 2. P. 137915. <https://doi.org/10.1016/j.foodchem.2023.137915>

feeding, as well as for the production of dairy products with prebiotic qualities for children of all age groups¹⁸. In European and Asian countries, mares' milk is widely studied in pediatrics and dietetics, innovative technologies for processing and long-term storage of mares' milk without loss of useful properties are being developed^{19, 20, 21, 22}.

In Ukraine, an interesting example of the popularization of productive horse breeding is the company "DendoffAgroFamily", which in the Tetivsky district of the Kyiv region founded the trademark MLK PWR ("Milk Power") for the production of koumiss and other products from the milk of mares and cows²³.

Therefore, the production of mares' milk is considered as a promising direction of animal husbandry and food industry. Our research is devoted to the development of this topical issue.

1. Efficiency of mares' milk production

The analysis of literature sources does not cover much research on determining the economic efficiency of horse breeding in general, and productive horse breeding in particular. Most of the analyzed information sources indicate that the efficiency of productive horse breeding depends, first of all, on reducing the cost of production. Thus, in his study, Kukla O. L.²⁴ notes that in heavy horse breeding, the production of milk for processing into koumiss makes it possible to reduce the cost of keeping horses, increase the net profit from horse breeding and, accordingly, its profitability. This indicator can theoretically be increased due to a decrease in feed costs due to the use of pasture.

The analysis of literature sources showed that the issue of the economy of both working and productive horse breeding at the present level has been little studied. The study of the economic efficiency of the horse breeding industry,

¹⁸ Aitbaeva S., Bimbetov B. Mare's milk in children's food. *Medicine (Almaty)*. 2016. Vol. 12(174). P. 101–103. http://www.medzdrav.kz/images/magazine/medecine/2016/2016-12/M_12-16_101-103.pdf.

¹⁹ Alabiso M., Maniaci G., Luigia Alicata M., Iannolino G., D'Amico, A., Bauman, D. E., Giosuè C. Effects of the foal at the milking and dietary supplementation with extra virgin olive oil on jennet milk production. *Italian Journal of Animal Science*, 2009. № 8. P. 688–690.

²⁰ Auclair-Ronzaud J., Jaffrézic F., Wimel L., Dubois C., Laloy D., Chavatte-Palmer P. Estimation of milk production in suckling mares and factors influencing their milk yield. *Animal*. 2022. Vol. 16, doi.org/10.15454/3LPGKP

²¹ Čagalj M., Brezovečki A., Mikulec N., Antunac N. Composition and properties of mare's Croatian coldblood horse breed. *Mljekarstvo* 2014; 64: 3–11. <https://hrcaak.srce.hr/117064>

²² Cais-Sokolińska D., Worjowski J., Pikul J. Rheological, texture and sensory properties of kefir from mare's milk and its mixtures with goat and sheep milk. *Mljekarstvo*. 2016. Vol. 66(4). P. 272–281. <https://doi.org/10.15567/mljekarstvo.2016.0403>

²³ URL:<https://agri-gator.com.ua/2019/07/03/ahrofirma-z-kyivshchynny-vypuskatyme-kumys-pid-vlasnym-brendom-kurkul/> (дата звернення 18.04.2026)

²⁴ Kukla O. L. Reserves for Cost Reduction in Breeding Horse Breeding in Ukraine. *Businessinform*. 2012. № 9. C. 142–145.

productive in particular, will serve as a basis for further popularization of currently free areas of production of promising healthy food products.

It has been established that almost all farms for breeding heavy horses are multi-sectoral: in addition to crop production, animal husbandry in them is represented by many developed areas – dairy and beef cattle breeding (stud «LANN», stud «Agro-Dibrivka»), breeding pig breeding and beekeeping (branch "Dibrivsky stud farm No. 62" of the State Enterprise «Horse Breeding of Ukraine»), sheep breeding (stud «Agro-Dibrivka», stud «LANN»). Animal husbandry in these enterprises is served by horses, which provides for the possibility of saving and reducing the cost of production.

Kazakh scientists note that the index of return on investment invested in the production of traditional and freeze-dried kumis is 26.9%, while production pays off in 3.7 years. The fact that festivals dedicated to kumis are held annually in Kazakhstan with a significant prize fund indicates an increase in the popularization of this product on the market²⁵.

Domestic researchers insist that the production of mares' milk is highly profitable, does not require significant expenditures of funds, energy and human resources, and is safe for the environment, because it involves organic, natural animal husbandry²⁶. However, there is still no solid answer to this question.

Generalization of the results of the analysis of literature sources proves the positive attitude of the majority of scientists to the use of horses as productive animals, as well as energy means on farms for the production of organic products, in regions with difficult terrain and in specialized educational farms that draw public attention to historical traditions, restoration of relict technologies and healthy life in the system of agricultural production using natural resources.

2. Selection of the object and methods of research

As an object of research, mares of the domestic Novooleksandrivsky draft breed, which are bred in horse breeding enterprises of Ukraine, were chosen. Studies on the study of milk productivity of mares of the Novooleksandrivsky draft breed, depending on morphofunctional indicators, were carried out during 2013–2024 in stud «LANN» of the Donetsk region and the branch «Dibrivsky stud farm No. 62» of the State Enterprise «Horse Breeding of Ukraine» of the Poltava region. Clinically healthy mares were included in the experiment according to the recommendations of a veterinarian. Milking of

²⁵ URL: <https://dairynews.today/kz/news/astana-gotovitsya-k-krupneysheму-festivalyu-kumysa-prizovoy-fond-konkurs-sostavit-45-mln-tenge.html> (accessed 18.04.2026)

²⁶ Pavlovsky S. S., Tkacheva I. V. Genealogical structure of the Novooleksandrivska heavy breed. *Scientific and Technical Bulletin of the Institute of Animal Husbandry of the National Academy of Sciences of Ukraine*. 2019. № 122. C. 130–138. <https://doi:10.32900/2312-8402-2019-122-130-138>

mares began when the foals reached the age of 2 months. Control milking was carried out using the DDU-2 milking machine in separate buckets. Sanitation of the udder and milking's in mares of all groups was carried out using an antiseptic solution.

On the day of control milking, foals received the required amount of milk through artificial feeding, which did not affect their condition and weight gain. After each milking, the amount of milk in the bucket was measured, the total daily milk yield was determined as the sum of both milking's per day. Indicators of daily milk yield and milk quality during lactation were determined, including for the first and second milking's per day, depending on the lactation period, age of mares, duration of pregnancy, and sex of foals.

The milk production of mares was estimated by the amount of milk milked and sucked by foals. The intensity of milk formation in mares during the day is almost the same, therefore, the daily productivity was determined by control milking, taking into account the milk sucked by foals.

Milk samples were taken in sterile containers with a preservative. When taking milk samples, they were guided by the European requirements of Codex Alimentarius, Vol. 13 «Methods of Analysis and Sampling» and DSTU ISO 707:2002 Milk and Dairy Products, Instructions for Sampling. Samples were taken with a sterile syringe in proportion to the first and second milking's per day, cooled to 10°C and immediately delivered to the laboratory in a thermobox. Only milk samples were analyzed, which were visually determined as whole, pure, in consistency were a solid white liquid with a slight bluish tint, without sediment and clots, with a delicate milky smell.

The physical and technological properties of milk were investigated in accordance with DSTU 8009:2015. Biochemical parameters of milk were determined in a certified laboratory for assessing the quality of livestock products. The chemical composition of milk (content of fat, protein, lactose, dry matter, protein, skimmed milk powder, %) and freezing point (°C) was determined according to ISO 9001:2000 instrumentally on the device «Bentley-150» (certificate IDA 0001461-1 dated 16.12.2004). The content of somatic cells (thousand/cm³) was determined according to ISO 9001: 2000 instrumentally on the device «Somacount-150» (certificate IDA 0001461-1 dated 16.12.2004).

The relationships between the studied indicators were determined by calculating the correlation coefficient (r).

All experimental studies were carried out in accordance with modern methodological approaches, requirements and standards, in particular DSTU ISO/IEC 17025:2005. Keeping animals and all manipulations were carried out in accordance with the Order of the ECM of Ukraine No. 416/20729 «On Approval of the Procedure for Conducting Experiments and Experiments on

Animals by Research Institutions» (Law of the Ministry of Education and Science, Youth and Sports of Ukraine No. 249 of 01.03.2012). The experiments were carried out in accordance with the general principles of humane treatment of animals, which was adopted at the first national congress on bioethics (Kyiv, 2001, Reznikov, 2001) and was consistent with the provisions of the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 18.03.1986).

3. Factors influencing the milk production of mares

Month of milking and lactation periods. In our study, milking of mares began when all born foals of 2 months of age reached the possibility of feeding them with concentrated and roughage. The dynamics of the lactation curve proves (Fig. 1) that the maximum daily milk yield of mares fell on July-August (1.075 ± 0.08 and 1.117 ± 0.07 liters, respectively), and after weaning foals – on November due to prolongation of lactation with the use of three milking's.

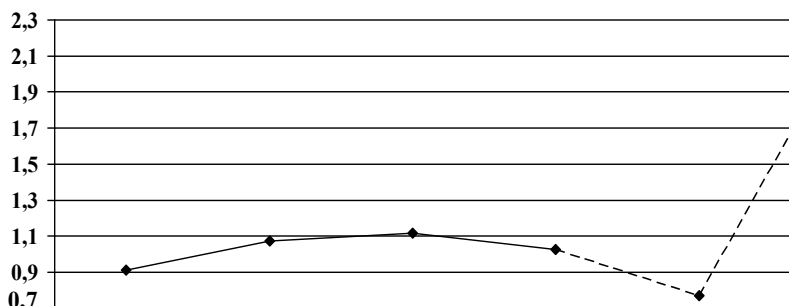


Fig. 1. Dynamics of daily milk yield of experimental mares during the milk production season

To study the daily dynamics of milk yield, 4 analogue mares of the same age were selected from the entire sample, who were at the same lactation periods, and milked them according to imitation of foal feeding. At the same time, the foals were kept next to the mares in direct contact with their mothers, but without access to the udder. The mares were milked 8 times a day with breaks of 3 hours around the clock in the presence of foals, the milk was completely fed to the foals, except for samples taken for research.

A comparison of milk production of experimental mares in the first full month of milking (June) and the third – the most productive month of milking (August) was carried out. The analysis of milk production of experimental mares based on the results of control milking's found that the daily milk yield

during double milking in the 1st control month of milking was on average 0.381 liters lower in the experimental sample than in the 3rd month (Table 1).

Table 1

Indicators of milk production of daily milk yield of mares depending on the month of milking

Showcases	1st month of milking				3rd month of milking			
	M±m	Cv, %	min	max	M±m	Cv, %	min	max
Daily milk yield, l	2,46±0,21	33,2	1,1	4,9	2,78±0,24	34,5	1,6	5,9
I Milking	1,08±0,13	47,1	0,6	2,7	1,10±0,08	28,6	0,5	1,9
II Milking	1,38±0,10	28,4	0,4	2,2	1,68±0,18	42,8	1,1	4,0

Obviously, in both the first and third months of milking, more milk was obtained from the second milking (by 0.300 liters in June and 0.587 liters in August). All studied indicators of daily milk yield are characterized by high rates of the coefficient of variation.

According to the adopted technology, the mating of mares, and, accordingly, their foaling, are seasonal, which means that the foals of experimental mares took place in February-March. In this regard, the indicator of lactation in the first month of milking fluctuated within the limits: 62–141 days; in the third month of milking – 114–193 days. According to this, according to the results of control milking in the first month of milking, mares were distributed by gradations: 62–90 (3 months), 91–120 (4 months), 121–141 days (5 months); in the third month: 114–150 (5 months), 151–180 (6 months), 181–193 (7 months).

Taking into account the fact that the duration of lactation of the proportion of mares, the control milking of which was carried out in June and August, fell on the 5th month, the gradations for lactation were corrected in the summary. In accordance with the established gradations, the value of daily milk yield was determined (Table 2).

Thus, according to the indicators of control milking in June, mares who were lactating for 114-150 days (3.27 ± 0.86 , $p \leq 0.01$) were distinguished by the highest daily milk yield, and in August – 62-90 days (4.20 ± 1.70 kg, $p \leq 0.01$). The level of correlation coefficient between daily milk yield and lactation was negative: higher in June ($r = -0.374$) and lower in August ($r = -0.218$).

Correlation analysis proved that the own daily milk yield of the same mares in June and August was significantly interrelated ($r = 0.695$). At the same time, milk yield for the first milking correlated with much greater strength ($r = 0.771$) than for the second ($r = 0.398$).

Table 2

Indicators of daily milk yield of experimental mares depending on the timing of lactation

Lactation dates, days	n	Milk yield, kg		
		I Milking	II Milking	Daily milk yield
1st month of milking				
62–90	2	2,15±0,55	1,80±0,35	3,95±0,86
91–120	6	0,82±0,05	1,30±0,13	2,15±0,16
121–141	8	1,11±0,13	1,36±0,14	2,50±0,26
On average:	16	1,078±0,127	1,378±0,098	2,463±0,205
3rd month of milking				
114–150	2	1,55±0,35	2,65±1,70	4,20±1,70
151–180	10	0,90±0,10	1,63±0,21	2,47±0,24
181–193	4	1,13±0,07	1,48±0,10	2,66±0,17
On average:	16	1,097±0,079	1,684±0,180	2,781±0,240

Milking time during the day. The dynamics of daily milking shows (Fig. 2) that the maximum milk yield occurred at 21 hours. (1.350±0.253 kg), and the lowest at 06 hours. (0.875±0.160 kg).

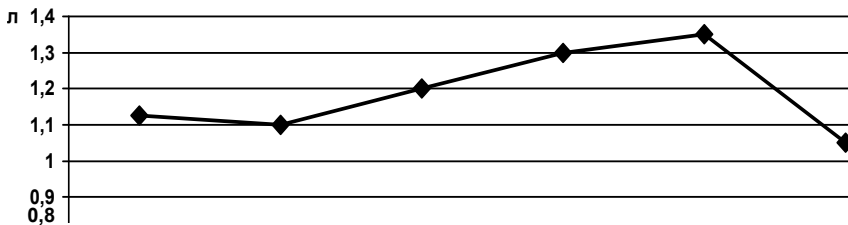


Fig. 2. Dynamics of daily milk yield of experimental mares of the Novooalexandrivsky heavy draft breed (kg) under imitation of foal feeding by milking hours

On average, 9.30±0.94 kg of milk per 1 mare was obtained per day of control milking (lim=6.9–11.0 kg). On average, 1.165±0.120 kg of milk was obtained per 1 milking (lim=0.86–1.38 kg) (Table 3.19). Therefore, according to the estimated data for 5 months of lactation, the mare produced an average of 1953 kg of milk with limits of 1449–2310 kg of milk.

Linear measurements and indices of body structure. The influence of morphofunctional indicators of mares on their milk production was studied. The study was carried out during the main lactation season (May–September) at stud «LANN» (n=32). The mares were divided into two groups according to

type: large (height at withers >150 cm, chest girth >190 cm) and small (height at withers <150 cm, chest girth <190 cm).

The group of large mares outnumbered small mares by 10.1% in terms of milk production obtained during the experimental period (Table 3).

Table 3

Indicators of measurements, live weight and milk production of experimental mares

Groups of mares by type		Body measurements, cm					
		Height at the withers	Oblique body length	Chest girth	Metacarpal circumference	Live weight, kg	Milk yield, liters
Small (n=20)	M±m	146,9 ±0,51	156,5 ±0,93	188,8 ±1,77	21,17 ±0,19	660,9 ±6,20	684,0 ±66,8
	Cv, %	1,21	2,05	3,25	3,08	3,25	33,8
Large (n=12)	M±m	154,4 ±0,51	162,8 ±0,70	192,1 ±1,84	21,70 ±0,13	673,9 ±6,29	761,0 ±72,7
	Cv, %	1,46	1,93	4,28	2,63	4,17	42,7
Total (n=32)	M±m	151,9 ±0,75	160,4 ±0,78	190,9 ±1,34	21,5 ±0,11	669,1 ±4,64	732,1 ±51,6
	Cv, %	2,78	2,74	3,97	3,01	3,93	39,9

The analysis of the correlation coefficients did not establish a significant relationship between the linear measurements of mares and their milk production. The highest relationship was established between the milk production index and height at the withers ($r=0.112$) and the oblique body length ($r=0.109$).

The repeated experiment was carried out on mares of the branch «Dibrivsky Stud Farm No. 62» of the State Enterprise «Horse Breeding of Ukraine» (n=16). In addition to indicators of milk production and linear measurements of the body, body structure indices were determined.

The milk production of experimental mares for 150 days of lactation averaged 2815.3 ± 234.77 kg of milk (lim=1603–3792 kg).

The height at the withers of the studied sample of mares averaged 150.4 ± 0.75 cm, which means that the horses of the Novoalexandrivsky draft breed belong to small draft horses close to the Ardennes. The oblique length of the body – 158.4 ± 0.98 cm – significantly exceeds the height at the withers, which indicates an expressive draft horse type. The average indicators of chest circumference (192.8 ± 1.72 cm) and metacarpal girth

(21.9±0.22 cm) indicate the desired massiveness and skeletal development mares.

In this experiment, the group of large mares outnumbered small mares by only 3.9% in terms of milk production obtained during the experimental period (Table 4).

Table 4

Indicators of body measurements and body structure indices of experimental mares

Groups of mares by type		Body measurements, cm				Body structure indexes, %			Milk production, l
		Height at the withers	Oblique body length	Chest girth	Metacarpal circumference	Format	Massiveness	Ratio of metacarpal circumference to withers height	
Small (n=7)	M±m	148,1 ±0,34	156,7 ±0,78	191,9 ±2,41	21,6 ±0,34	105,8 ±0,68	129,5 ±1,59	14,6 ±0,21	2761,0 ±280,0
	Cv, %	0,61	1,31	3,32	4,16	1,69	3,27	3,76	26,83
Large (n=9)	M±m	152,2 ±0,94	159,7 ±1,55	193,4 ±2,53	22,1 ±0,29	104,9 ±0,72	130,4 ±3,73	14,5 ±0,17	2872,7 ±191,26
	Cv, %	1,85	2,90	3,92	3,88	2,05	8,59	3,44	19,97
Total (n=16)	M±m	150,4 ±0,75	158,4 ±0,98	192,8 ±1,72	21,91 ±0,22	105,3 ±0,49	130,0 ±2,15	14,6 ±0,13	2815,3 ±234,77
	Cv, %	1,99	2,48	3,58	4,02	1,89	6,63	3,47	23,43

It was found that mares, the height at the withers of which exceeded 150 cm (large type), were characterized by probably higher milk yield during lactation than smaller mares (by 111.7 l, p<0.01), which confirms the data obtained in the first experiment. It was found that the indicator of milk productivity of mares of the Novooleksandrivsk heavy draft breed with different strengths is positively related to body measurements: height at the withers (r=0.132), oblique body length (r=0.232), chest girth (r=0.280), metacarpal girth (r=0.245), format index (r=0.175), ratio of metacarpal circumference to withers height (r=0.194) and, least, with a massiveness index (r=0.096).

Udder parameters. In addition to indicators of milk production and body measurements of experimental mares, udder measurements (cm) were determined: girth, length, depth. Udder parameters on average were: girth – 65.6±1.25 cm, length – 19.7±0.44 cm, depth – 18.4±0.33 cm. Large mares

were characterized by higher indicators of girth and udder length, small mares prevailed in udder depth (Table 5).

Table 5

Indicators of milk production and udder measurements of experimental mares

Groups of mares by type		Udder measurements, cm			Milk production, l
		Girth	Length	Depth	
Small (n=7)	M±m	65,22±1,71	19,44±0,41	18,56±0,52	2761,0±280,0
	Cv, %	7,85	6,36	8,46	26,83
Large (n=9)	M±m	66,14±1,98	20,00±0,87	18,14±0,39	2872,7±191,26
	Cv, %	7,93	11,55	5,67	19,97
Total (n=16)	M±m	65,63±1,26	19,69±0,44	18,38±0,33	2815,3±234,77
	Cv, %	26,65	8,84	7,27	23,43

Calculations of the correlation coefficient proved that the milk productivity of the studied mares is related to the measurements of their udder (Table 6).

Table 6

Correlations between milk production, body measurements and udder parameters

Udder parameters	Milk production, l	Height at the withers	Oblique body length	Chest girth	Metacarpal circumference	Format index	Massiveness index	Ratio of metacarpal circumference to withers height
Girth	0,370	-0,175	0,352	0,228	0,263	0,654	0,514	0,391
Length	0,301	-0,126	0,145	0,310	0,371	0,323	0,245	0,486
Depth	-0,113	0,140	0,232	0,224	0,557	0,157	0,449	0,545

Positive correlation coefficients of the average strength of the bond between the milk production of mares and the girth of the udder ($r=0.370$) and the length of the udder ($r=0.301$) were revealed, with the depth of the udder the ligaments are weak and negative ($r=-0.113$). A fairly strong relationship was found between the udder measurements: girth \times length ($r=0.665$), length \times depth ($r=0.570$), girth \times depth ($r=0.361$).

In addition, udder parameters with a fairly high positive value correlate with linear measurements of the body. Therefore, the udder girth indicator significantly and positively correlates with the indicators of body structure index: format ($r=0.654$), massiveness ($r=0.514$), ratio of metacarpal circumference to

withers height ($r=0.391$). The udder length index is positively and significantly correlated with the ratio of metacarpal circumference to withers height ($r=0.486$) and format ($r=0.323$).

Age of mares. The infusion of the age of mares on daily milk yield indicators is shown in Table 7.

Table 7

Indicators of daily milk yield of experimental mares depending on age

Age of mares, years	n	Amount of milk, l		
		I Milking	II Milking	Daily milk yield
1st month of milking				
4–8	6	0,842±0,052	1,425±0,070	2,267±0,087
9–13	6	1,167±0,313	1,217±0,240	2,400±0,531
14 and older	4	1,300±0,147	1,550±0,106	2,850±0,205
On average:	16	1,078±0,127	1,378±0,098	2,463±0,205
3rd month of milking				
4–8	6	0,883±0,087	1,400±0,100	2,283±0,180
9–13	6	1,192±0,156	2,033±0,445	3,225±0,564
14 and older	4	1,275±0,075	1,588±0,156	2,863±0,221
On average:	16	1,097±0,079	1,684±0,180	2,781±0,240

It was found that the indicators of control milking of mares of different ages proportionally vary both in the 1st and in the 3rd month of milking. A predominance in the daily milk yield of older mares (14 years and older) in June, and at the age of 9–13 years in August, was revealed. The results obtained are confirmed by the calculation of the correlation coefficient between the daily milk yield and the age of mares, which indicates the presence of a positive relationship of average strength between the age and daily milk yield of the studied mares ($r=431$).

Duration of pregnancy. The age of mares affects the duration of their pregnancy, as evidenced by the calculated positive probable correlation coefficient of the average degree ($r=0.396$). The duration of pregnancy of experimental mares averaged 335.6 ± 2.85 days ($lim=320 \setminus u2012358$) ($Cv=3.176$).

The impact of the duration of pregnancy of mares on the indicators of daily milk yield is shown in Table 8. The advantage in daily milk yield of mares with a gestation duration of more than 350 days was proven according to the results of control milking in both the first and third control months of milking.

The daily milk yield correlated significantly and positively with a high probability ($p<0.01$) with the duration of pregnancy of experimental mares in June ($r=0.759$), according to milk yield in August, this correlation was much lower ($r=0.270$). The duration of pregnancy on average was positively and

Table 8

**Indicators of daily milk yield of experimental mares depending
on the duration of pregnancy**

Duration of pregnancy, days	n	Milk yield, kg		
		I Milking	II Milking	Daily milk yield
1st month of milking				
320–330	4	0,867±0,186	1,233±0,088	2,100±0,265
331–340	7	1,000±0,049	1,429±0,071	2,500±0,076
341 and more	5	1,213±0,142	1,988±0,218	3,200±0,117
On average:	16	1,097±0,079	1,684±0,180	2,781±0,240
3rd month of milking				
320–330	4	1,015±0,009	1,283±0,017	2,317±0,044
331–340	7	0,857±0,047	1,400±0,072	2,257±0,083
341 and more	5	0,988±0,200	1,200±0,331	2,188±0,503
On average:	16	1,078±0,127	1,378±0,098	2,463±0,205

probably correlated with the age of mares ($r=0.429$). It was found that stallions of mares were carried 9.1 days longer than fillies ($p<0.05$).

The sex of the foal. It was found that mares foaled by foals with a high degree of probability ($p<0.01$) had a higher daily milk yield, as well as milk yield for the first and second milking's (Table 9). Perhaps this is due to the fact that colts are born larger and need more milk, which is controlled by the mare's hormonal background^{27, 28}. The milk yield in the first month of mares who gave birth to colts was probably higher (by 0.511 l, $p<0.01$) than in the third month of milking. In mares who gave birth to fillies, the level of milk yield remained unchanged with slight fluctuations between the first and second milking's.

Therefore, it has been proved that the milk productivity of mares of the Novooalexandrivsky draft breed is influenced by factors to varying degrees: the month of milking and lactation, milking times throughout the day, linear measurements and conformation scores, udder parameters, mare's age, gestation length, foal's sex.

²⁷ Aoki T., Inoue Y., Murase H., Asai Yo, Nambo Y., Ishii M. Relationship Between Fertility at Foal Heat and Blood Biochemistry Parameters Monitored During the Peripartum Period in Thoroughbred Mares, *J. of Equine Veterinary Sci.* 2013. Vol. 33, Iss. 12. P. 1064–1067, <https://doi.org/10.1016/j.jvevs.2013.04.003>.

²⁸ Robles M, Nouveau E, Gautier C, Mendoza L, Dubois C, Dahirel M, Lagofun B, Aubrière MC, Lejeune JP, Caudron I, Guenon I, Viguié C, Wimmel L, Bouraima-Lelong H, Serteyn D, Couturier-Tarrade A, Chavatte-Palmer P. Maternal obesity increases insulin resistance, low-grade inflammation and osteochondrosis lesions in foals and yearlings until 18 months of age. *PLoS One.* 2018 Jan 26; 13(1):e0190309. <https://doi.org/10.1371/journal.pone.0190309>. PMID: 29373573

Table 9

**Indicators of daily milk yield of experimental mares depending
on the month of milking and the sex of foals**

The foal's sex	n	Milk yield, kg		
		I Milking	II Milking	Daily milk yield
1st month of milking				
Colts	10	1,094±0,078	1,628±0,148	2,722±0,168
Filly	6	0,910±0,046	1,410±0,105	2,320±0,085
3rd month of milking				
Colts	10	0,933±0,091	1,267±0,137	2,211±0,210
Filly	6	0,920±0,107	1,400±0,114	2,320±0,208

4. Factors influencing the quality indicators of mares' milk

Lactation periods. The first experiment was carried out on mares of the Dibrivsky stud farm. Tasting analysis established (Table 10) that the taste, color and smell of the studied milk samples were characteristic of mares' milk (sweetish taste, pure milky smell, white color).

In terms of density, acidity and degree of purity, the studied milk samples of mares of the Novoolexandrivsky draft breed fully met the requirements of the current standard (DSTU 8009:2015). During the studied periods, no probable difference in the samples in terms of density and degree of purity of milk was observed.

The influence of lactation dates on the physicochemical parameters of milk of experimental mares was established (Table 10). Therefore, the acidity index of milk samples obtained from mares up to the 60th day of lactation inclusive was the lowest, and at 61–90 days of lactation – increased.

The mass fraction of dry matter in the milk of experimental mares was at the level of 9.17–9.49% depending on the timing of lactation: a larger amount of dry matter was observed in the milk of mares at 2–3 months of lactation, at 3 months the dry matter content decreased slightly and was lowest at the end of lactation.

The mass fraction of fat in the milk of experimental mares was characterized by high variability and ranged on average from 0.44 to 0.80%, which is lower than the requirements of the standard (not lower than 1%). The highest fat content in the milk of mares was observed at 2–3 lactation sites ($p < 0.01$).

The mass fraction of protein in the milk of experimental mares ranged on average from 1.25 to 2.10%, which exceeded the requirements of the standard. The protein content in the milk of mares, as well as the fat content, was highest at the lactation stage of 2–3 months, the lowest at the end of lactation. The content of casein in milk was more stable in relation to the timing of lactation,

Table 10

**Physicochemical parameters of milk of experimental mares
by lactation period**

Indicator	Lactation dates, days				Standard requirements
	≤60 (n=6)	61–90 (n=5)	91–120 (n=12)	121≥ (n=5)	
Density, °A	1317±48,0	1380±20,0	1350±29,0	1380±20,0	1027–1035
Acidity, °T	4,17±0,60	6,20±0,58	5,08±0,48	5,20±0,37	5,0–7,0
Degree of cleanliness by class	I	I	I	I	I
Mass fraction, %					
Dry matter	9,48±0,27	9,49±0,17	9,41±0,09	9,17±0,05	9,5
Fat	0,68±0,22	0,80±0,33	0,44±0,09	0,46±0,02	≥1
Protein	1,61±0,21	2,10±0,24	1,80±0,18	1,25±0,07	≥1
incl. casein	0,99±0,09	1,02±0,05	0,98±0,07	1,08±0,07	–
Albumins & Globulins	0,62±0,23	1,09±0,23	0,83±0,14	0,16±0,04	–
Lactose	6,57±0,16	6,49±0,17	6,67±0,15	6,64±0,11	6,6
Skimmed milk powder	9,13±0,14	9,05±0,05	8,97±0,06	8,99±0,05	–

the difference in its mass fraction during the studied periods was unlikely. The content of albumin and globulins in the milk of mares, on the contrary, had significant fluctuations in terms of lactation, it was highest at 2–3 months of lactation and very low – after the fourth month of lactation (0.16%). The lactose content in the milk of mares fluctuated improbably, according to the timing of lactation, in general, was at the level of the requirements of the standard.

The dry skimmed residue in milk was 8.97–9.13%, which is higher than the requirements of the standard. During the studied periods, there was no probable difference in these indicators, although there was a tendency to their slight decrease with an increase in the lactation period.

In the next experiment, the quality of milk of mares of stud «LANN» was studied. The mares were divided into the same gradations as in the previous experiment with the inclusion of colostrum-producing mares in the first days of lactation (Table 11).

It should be noted that in almost all respects, colostrum was dominated by mature milk, in addition to the lactose content and freezing point, somatic cells were almost not detected.

The mass fraction of dry matter in the milk of experimental mares was at the level of 10.097±0.062%, the highest content of dry matter was observed in the milk of mares in the early stages of lactation (9.501±0.130%), after which this indicator decreased during lactation.

Milk indicators of experimental mares by lactation

Indicator	Colostrum (n=3)	Lactation dates, days				on average (mature milk)
		≤60 (n=6)	61-90 (n=5)	91-120 (n=12)	121≥ (n=5)	
Fat, %	2,851 ±0,054	0,786 ±0,031	0768 ±0,032	0,803 ±0,029	0,783 ±0,042	0,785 ±0,017
Protein, %	3,683 ±0,188	2,405 ±0,135	1,913 ±0,033	1,758 ±0,047	1,701 ±0,097	2,041 ±0,076
Total protein, %	3,930 ±0,095	2,759 ±0,125	2,310 ±0,031	2,168 ±0,047	2,122 ±0,053	2,427 ±0,070
Lactose, %	5,842 ±0,123	6,741 ±0,083	6,924 ±0,033	6,994 ±0,059	7,174 ±0,048	6,886 ±0,043
Dry matter, %	12,622 ±0,111	9,501 ±0,130	9,234 ±0,027	9,161 ±0,098	9,292 ±0,036	10,097 ±0,062
Skimmed milk powder, %	9,774 ±0,132	10,284 ±0,128	10,001 ±0,040	9,964 ±0,097	10,072 ±0,112	9,313 ±0,062
Freezing point, °C	-0,631 ±0,005	-0,660 ±0,006	-0,669 ±0,002	-0,672 ±0,006	-0,684 ±0,007	-0,667 ±0,03
Somatic cells, thousand/cm ³	0,239 ±0,003	17,200 ±3,130	9,875 ±3,091	19,000 ±7,955	8,365 ±3,268	14,963 ±2,810

The mass fraction of fat in the milk of experimental mares was characterized by quite high variability ($C_v=11.026\%$) and fluctuated on average at the level of $0.785\pm0.017\%$. The highest fat content in the milk of mares who were lactating for 61–90 days ($0.803\pm0.029\%$) ($p<0.01$) was established.

The lactose content in the milk of experimental mares exceeded the requirements of the standard on average (not lower than 6.6%) and amounted to $6.886\pm0.043\%$. The lactose content was lowest in the milk of mares in the early stages of lactation and increased during its duration.

The content of protein and protein was higher at the beginning of lactation ($2.405\pm0.135\%$ and $2.759\pm0.125\%$, respectively). The content of casein in milk was within the normal range (50 % in total protein) was more stable in relation to the timing of lactation, its difference in mass fraction in the studied periods was unlikely. The content of albumin and globulins in the milk of mares, on the contrary, had significant fluctuations in terms of lactation, it was highest at 2–3 months of lactation, the lowest at the end of lactation (0.16%).

The content of skimmed milk powder in the studied samples was 8.97–9.13% (average $9.313\pm0.062\%$), which exceeds the requirements of the standard. The content of skimmed milk powder was probably highest in the milk of mares in early lactation ($10.284\pm0.128\%$), but the difference was improbable.

The freezing point indicator in all milk samples was slightly higher than the reference values, it was highest at the end of lactation. The content of somatic cells was insignificant and highest at 91–120 days of lactation.

Correlations between the studied indicators were determined. A high level of negative relationship between the day of lactation and the content of protein ($r=-0.707$), protein ($r=-0.693$) and positive – with lactose content ($r=0.660$) and freezing point was established.

According to milk quality indicators, the highest positive correlations between the concomitant indicators: protein and protein content ($r=0.999$), dry matter and SOMO ($r=0.963$), lactose and freezing point ($r=0.952$), dry matter and protein ($r=0.803$), protein and skimmed milk powder ($r=0.798$), protein and skimmed milk powder ($r=0.771$). The highest negative relationships were found between the content of protein and lactose ($r=-0.518$) and protein and lactose ($r=0.482$).

Month and number of control milking, level of milk production. The influence of the milking month on the quality of mares' milk quality has been established (Table 12).

Table 12

Indicators of milk production and quality of daily milk yield of mares depending on the month of milking

Indicator	1st month of milking		3rd month of milking	
	M±m	Cv, %	M±m	Cv, %
Content, %: dry matter	9,39±0,04	1,44	8,97±0,08	3,78
Fat	0,12±0,03	14,3	0,14±0,05	17,6
Protein	1,65±0,02	3,72	1,42±0,01	4,19
lactose	6,87±0,03	1,39	6,72±0,09	5,41
Skimmed milk powder, %	9,27±0,02	0,92	8,86±0,09	4,38
Fat/Protein Ratio	0,07±0,02	14,5	0,08±0,03	16,6
Freezing point, °C	0,66±0,01	1,06	0,64±0,01	4,30
Number of somatic cells, thousand/cm ³	0,39±0,27	24,8	2,35±1,50	26,3

It was found that the content of dry matter, protein, lactose and skimmed milk powder were higher in the first month of milking, and the protein content (and, accordingly, the ratio of fat and protein), freezing point and the number of somatic cells were higher in the third month of milking. In general, almost no somatic cells were found in the milk of mares, which is explained by its high antibacterial properties.

According to the average indicators of control milking of experimental mares with two milkings during the day, significant differences in milk quality indicators were established (Table 13).

Table 13

Milk quality indicators of experimental mares by milking number

Indicator	1 Milking			2 Milking		
	M±m	δ	Cv, %	M±m	δ	Cv, %
Fat, %	0,208±0,079	0,285	137,1	0,076±0,010	0,039	51,772
Protein, %	1,613±0,014	0,050	3,093	1,649±0,020	0,082	4,963
Ratio (fat/protein)	0,128±0,049	0,176	137,1	0,045±0,006	0,023	51,958
Lactose, %	6,877±0,029	0,106	1,536	6,833±0,025	0,100	1,459
Dry matter, %	9,447±0,087	0,314	3,322	9,308±0,023	0,092	0,989
Skimmed milk powder, %	9,241±0,028	0,101	1,091	9,233±0,021	0,084	0,912
Freezing point, °C	-0,659±0,002	0,008	1,287	-0,655±0,002	0,007	1,082
Somatic cell content, thousand / cm ³	0,308±0,208	0,751	244,097	0,438±0,302	1,209	276,420

It was found that in the milk samples of experimental mares taken during the first control milking during the day, the indicators of fat content, fat-protein ratio, lactose, dry matter, skimmed milk powder and freezing point temperature prevail. In the milk samples of experimental mares taken during the second control milking, the protein content and somatic cells were higher.

Milk quality indicators of the studied mares in samples from the first and second milking's per day are shown in Table 14.

Table 14

Milk quality indicators of experimental mares for 1 and 2 milking's

Milk quality indicators	1st month of milking		3rd month of milking	
	1 Milking	2 Milking	1 Milking	2 Milking
Content, %: dry matter	9,447±0,087	9,308±0,023	8,928±0,089	8,918±0,078
Fat	0,208±0,079	0,076±0,010	0,105±0,030	0,165±0,060
Protein	1,613±0,014	1,649±0,020	1,408±0,016	1,345±0,014
lactose	6,877±0,029	6,833±0,025	6,701±0,091	6,697±0,085
Ratio: fat/protein	0,128±0,049	0,045±0,006	0,074±0,021	0,121±0,044
Skimmed milk powder, %	9,241±0,028	9,233±0,021	8,824±0,098	8,752±0,090
Freezing point, °C	-0,659±0,002	-0,655±0,002	-0,642±0,007	-0,642±0,006
Number of somatic cells, thousand/cm ³	0,308±0,208	0,438±0,302	1,706±0,903	3,353±2,356

In milk taken in the first month of milking, a higher content of almost all studied indicators was found in milk samples from the first milking. Thus, the dry matter content in milk samples from the first milking was higher

by 0.139% ($p>0.01$) than from the second milking, the lactose content was 0.044%, the skimmed milk powder – by 0.008%, the freezing point indicator – by 0.004%. The highest difference in samples from the first and second milking's was in terms of fat content (0.208 ± 0.079 versus $0.076\pm 0.010\%$, $p>0.01$), and the ratio (fat/protein) was also significantly higher in samples from the first milking – 0.128 ± 0.049 versus 0.045 ± 0.006 , $p>0.01$, while the protein content in milk from the second milking was slightly higher than from the first (by 0.036%). A small number of somatic cells was detected only in two mares in the first month of milking and in four in the third, however, in general, it was higher in milk from the second milking (by 0.13 thousand/cm³).

In milk taken in the third month of milking, a higher content of almost all the studied indicators was also found in milk samples from the first milking, but with a much smaller difference. In particular, the dry matter content in milk samples from the first milking was 0.010% higher than from the second milking, the lactose content – by 0.004%, skimmed milk powder – by 0.072%, the freezing point indicator – did not differ by milking number. The fat content, on the other hand, was higher in the samples from the second milking (0.165 ± 0.060 versus $0.105\pm 0.030\%$, $p>0.01$), and the fat/protein ratio was also higher in the samples from the second milking (0.121 ± 0.044 versus 0.074 ± 0.021 , $p>0.01$), while the protein content in milk from the first milking was higher than from the second (by 0.063%). The content of somatic cells was higher in milk from the second milking (by 1.647 thousand/cm³).

High probable positive correlations (r) were found between the daily milk yield milked in the first month of milking and the content of dry matter ($r=0.856$), fat ($r=0.728$), and the ratio of fat and protein ($r=0.861$). In milk milked in the third month of milking, these relationships are weaker (0.634, 0.461 and 0.489, respectively).

It was found that the indicators of daily milk yield and milk quality of experimental mares significantly correlate with each other, in accordance with the number of control milking during the day.

Thus, the highest probable relationships were established between the dry matter content in the daily milk yield, the protein and dry matter content in the samples obtained from the first milking, the amount of milk, the content of dry matter, fat and protein in the samples from the second milking. The indicator of the content of skimmed milk powder residue was not actually related to the indicators of milk production in general and by the number of milking. Instead, the freezing point indicator in the range of up to 0.3 was positively correlated with the milk production of experimental mares.

Table 15

Relationship between milk production indicators and milk quality of mares in milk samples by control milking number (r)

Milk quality indicators	Amount of milk, l		
	1 Milking	2 Milking	Daily milk yield
Content, %: dry matter	0,321	0,528	0,412
Fat	0,569	0,708	0,690
Protein	0,788	0,342	0,578
lactose	0,303	0,265	0,281
Ratio: fat/protein	0,557	0,722	0,704
Skimmed milk powder, %	0,089	0,067	0,066
Freezing point, °C	0,299	0,265	0,280
Number of somatic cells, thousand/cm ³	-0,096	-0,126	-0,121

Most indicators of milk quality are significantly related to each other, which is proven by calculations of correlation coefficients. The indicators of dry matter and fat content ($r=0.796$), dry matter and ratio (fat/protein) ($r=0.808$), dry matter and skimmed milk powder ($r=0.776$), fat content and ratio (fat/protein) ($r=0.998$), lactose content and freezing point index ($r=0.984$), lactose and skimmed milk powder content ($r=0.776$) were the most positively correlated. The content of somatic cells was negatively correlated with all the studied indicators of milk quality, most of all with the content of skimmed milk powder ($r=-0.493$) and dry matter content ($r=-0.537$).

Type of mares (by size). The influence of morphofunctional indicators of mares ($n=16$) on the quality of their milk was investigated according to the results of the analysis of samples taken during control milking's (Table 16).

Table 16

Milk quality indicators of experimental mares of different types

Indicators	Type of mares			
	Small (n=7)		Large (n=9)	
	M±m	Cv, %	M±m	Cv, %
Content, %: dry matter	9,354±0,049	1,56	9,377±0,044	1,24
Fat	0,420±0,072	51,71	0,477±0,116	64,33
Protein	1,643±0,022	3,955	1,661±0,024	3,88
lactose	6,841±0,031	1,35	6,884±0,036	1,39
Ratio: fat/protein	0,711±0,023	9,90	0,475±0,080	45,35
Skimmed milk powder, %	9,234±0,018	0,57	9,300±0,036	1,01
Freezing point, °C	-0,656±0,02	1,00	-0,659±0,003	1,09

There is no probable difference between groups of small and large mares in terms of milk quality.

Age of the mare. The effect of the age of mares on milk quality indicators is shown in Table 17, the data of which prove the superiority in the content of dry matter in the milk of mares aged 10–13 years in June, and older (14 years and older) in August. In the groups of mares of the same age category, the fat content in milk was higher. The protein content was highest in the milk of mares aged 4–8 years in June and August, and the lactose content was higher in the oldest mares. The freezing point indicator differed little in different groups of mares, but was higher in older mares (14 years and older).

Table 17

Milk quality indicators of experimental mares of different ages by control months of milking (r is the correlation of indicators with age)

Milk quality indicators	Age of mares, years			
	1st month of milking			
n	4-8	9-13	14 and older	r
	6	6	4	
Content, %: dry matter	9,360±0,060	9,425±0,063	9,348±0,073	0,139
Fat	0,063±0,07	0,168±0,022	0,075±0,022	0,153
Protein	1,677±0,038	1,648±0,022	1,638±0,040	-0,005
lactose	6,870±0,083	6,857±0,033	6,885±0,052	0,046
Ratio: fat/protein	0,037±0,003	0,100±0,030	0,045±0,013	0,161
Skimmed milk powder, %	9,303±0,058	9,253±0,024	9,275±0,061	0,049
Freezing point, °C	0,657±0,006	0,657±0,002	0,659±0,004	0,089
Number of somatic cells, thousand/cm ³	0	2	3	0,244
3rd month of milking				
n	4-8	9-13	14 and older	r
	6	6	4	
Content, %: dry matter	8,970±0,082	8,947±0,233	9,000±0,012	0,075
Fat	0,043±0,016	0,227±0,116	0,040±0,011	0,185
Protein	1,442±0,017	1,410±0,035	1,428±0,021	-0,057
lactose	6,770±0,070	6,608±0,248	6,808±0,012	-0,017
Ratio: fat/protein	0,030±0,010	0,155±0,078	0,028±0,009	0,186
Skimmed milk powder, %	8,938±0,088	8,718±0,257	8,960±0,008	-0,033
Freezing point, °C	0,647±0,006	0,636±0,019	0,650±0,001	-0,007
Number of somatic cells, thousand/cm ³	2,000±1,291	43,000±42,403	0	0,041

Duration of pregnancy. The infusion of the duration of foaling of mares on milk quality indicators is shown in Table 18.

The superiority in dry matter, fat content and fat-protein ratio in milk samples of experimental mares with a duration of foaling of more than 340 days was proved according to the results of control milking in both the first and third control months of milking.

Table 18

Indicators of milk quality of experimental mares depending on the duration of pregnancy

Milk quality indicators	Duration of pregnancy, days			
	1st month of milking			
n	320–330	331–340	341 and more	r
	4	7	5	
Content, %: dry matter	9,267±0,015	9,338±0,060	9,628±0,204	0,369
Fat	0,067±0,003	0,100±0,033	0,298±0,187	0,242
Protein	1,583±0,032	1,625±0,025	1,620±0,032	0,206
lactose	6,873±0,039	6,865±0,069	6,950±0,039	0,300
Ratio: fat/protein	0,043±0,003	0,063±0,021	0,183±0,117	0,230
Skimmed milk powder, %	9,203±0,017	9,240±0,060	9,330±0,028	0,497
Freezing point, °C	0,657±0,003	0,657±0,005	0,666±0,004	0,364
Number of somatic cells, thousand/cm ³	0	2	2	0,024
3rd month of milking				
n	320–330	331–340	341 and more	r
	4	7	5	
Content, %: dry matter	8,930±0,056	9,001±0,064	8,773±0,298	-0,080
Fat	0,037±0,022	0,046±0,013	0,148±0,098	0,220
Protein	1,393±0,035	1,426±0,024	1,450±0,038	0,203
lactose	6,787±0,024	6,803±0,062	6,493±0,373	-0,147
Ratio: fat/protein	0,027±0,017	0,033±0,008	0,098±0,061	0,221
Skimmed milk powder, %	8,903±0,041	8,959±0,073	8,625±0,395	-0,127
Freezing point, °C	0,648±0,002	0,650±0,005	0,626±0,028	-0,139
Number of somatic cells, thousand/cm ³	0	2,143±1,100	225	0,144

Mares with a gestation duration of more than 340 days also had the highest lactose content and freezing point in samples taken in the first control month of milking and protein in samples taken in the third month of milking. Mares with a gestation duration of 331–340 days had the highest content of protein and

skimmed milk powder in milk samples obtained in the first month of milking and freezing point in samples obtained in the third month of milking.

Sex of foals. Indicators of milk quality of experimental mares in connection with the sex of their foals are given in Table 19.

It was found that milk samples (taken both in the first and third control months of milking) of mares who gave birth to stallions had a higher content of dry matter (by 0.448 and 0.335 ml, respectively), fat (by 0.08 and 0.12%, respectively), and the ratio of fat and protein. The protein content was higher in the samples taken in the first month from mares who gave birth to fillies, and in the third month – from mares who gave birth to stallions, however, the difference is insignificant and unlikely.

Table 19

Indicators of milk quality samples of control milk of experimental mares depending on the sex of their foals

Milk quality indicators	1st month of milking		3rd month of milking	
	Colts	Fillies	Colts	Fillies
Content, %: dry matter	9,440±0,043	9,265±0,021	8,992±0,136	8,930±0,071
Fat	0,140±0,036	0,060±0,013	0,156±0,073	0,036±0,012
Protein	1,644±0,021	1,668±0,031	1,435±0,018	1,412±0,028
lactose	6,900±0,032	6,798±0,025	6,688±0,147	6,770±0,070
Ratio: fat/protein	0,083±0,021	0,035±0,006	0,106±0,049	0,027±0,008
Skimmed milk powder, %	9,300±0,028	9,208±0,023	8,834±0,156	8,907±0,081
Freezing point, °C	-0,660±0,002	-0,652±0,002	-0,642±0,011	-0,647±0,005
Number of somatic cells, thousand/cm ³	0	1,250±0,750	26,00±25,45	1,667±1,174

The lactose content, on the other hand, was higher in samples taken in the first month of milking from mares who gave birth to stallions, and in the third month from mares who gave birth to fillies. In terms of dry skimmed milk residue, there was a significant advantage in the milk of mares taken in the first month (with a predominance of fillies who gave birth to colts). In milk samples taken in the third month, the indicator of dry skimmed milk residue was lower, but, with an incredible difference, in favor of mares who gave birth to fillies.

The freezing point indicator varied little and improbably due to the sex factor of the foals, however, it prevailed in milk samples taken in the first month from mares that gave birth to stallions, and in the third month from mares that gave birth to fillies.

A small number of somatic cells were found in milk samples taken in the first month of milking from two mares who gave birth to fillies, in the third

month of milking – from four mares who gave birth to foals of both sexes, however, we consider it inappropriate to associate this indicator of milk quality with the sex of foals.

Thus, it has been established that the factors of the month, milking number, lactation period, age of mares, duration of their pregnancy and sex of foals affect individual indicators of milk quality to varying degrees. Further research should be directed to a more detailed study of the quality of mares' milk and the establishment of factors influencing its indicators.

CONCLUSIONS

Factors influencing milk productivity and milk quality of mares of the Novooleksandrivsk heavy cart breed have been established.

The highest level of milk production of experimental mares was established in the second and third months of milking (2–3 months). In the first and third control months of milking, it was found that with two daily milkings, more milk was obtained from the second milking. (1.350 ± 0.253 kg), and the lowest at 06 hours. (0.875 ± 0.160 kg).

The highest daily milk yield was characterized by mares that began to lactate later. Therefore, in the first month of milking, mares that were lactating for 114–150 days (3.27 ± 0.86 , $p \leq 0.01$) were distinguished by the highest milk yield, and in the third month – 62–90 days (4.20 ± 1.70 kg, $p \leq 0.01$). The influence of lactation periods on the physicochemical parameters of milk of experimental mares was established.

The predominance of large-type mares (height at the withers < 150 cm, chest girth < 190 cm) in terms of milk production by 10.1% was established. There was no probable difference between groups of small and large mares in terms of milk quality.

The influence of udder parameters on the indicator of milk production of mares was proved. Positive correlation coefficients of the average strength of the bond between the milk production of mares and udder girth ($r=0.370$) and udder length ($r=0.301$) were revealed. A fairly strong relationship was found between udder measurements: girth \times length ($r=0.665$), length \times depth ($r=0.570$), girth \times depth ($r=0.361$).

A preponderance in daily milk yield of older mares (9 years and older) was revealed. The results obtained are confirmed by the calculation of the correlation coefficient between age and daily milk yield of the studied mares ($r=0.431$).

The age of mares affects the duration of their foaling ($r=0.396$). The advantage in daily milk yield of mares with a foal duration of more than 350 days was proven. The advantage in dry matter, fat and the ratio of fat and protein in the milk samples of experimental mares with a foal duration of more

than 340 days was proved. It was also found that mares foaled by stallions were characterized by better milk production ($p < 0.01$), a higher content of dry matter and fat in milk in the first month of milking.

SUMMARY

In most European countries, environmental issues are not yet considered important enough for stakeholders in the field of horse breeding. However, thanks to their «green» assets, horses can play an active role in the ecological transition and debate, both independently and as a supplement to other economic productions and services, which is the economic guarantee of the conservation of horses of local populations. In this context, one of the most promising areas of use of horses is the production of hypoallergenic milk of mares and products of its processing. Therefore, new knowledge is needed regarding the parameters of milk production of mares of domestic populations. In our research, it has been proved that the milk productivity of mares of the Novooalexandrivsky draft breed is influenced by factors to varying degrees: the month of milking and lactation periods, milking time during the day, linear measurements and indices of body structure, udder parameters, age of the mare, duration of foaling, sex of the foal. It has also been established that the factors of the month, milking number, lactation period, age of mares, duration of their foal and sex of foals affect individual indicators of milk quality. Further research should be directed to a more detailed study of the quality of milk of mares and the establishment of factors influencing its indicators.

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