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Genetiac Potential Of Milk Productivity Of The Russian Heavy Draft Mares

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ABSTRACT
The presence of record-breaking dairy mares among heavy draft horses characterizes both the effectiveness of breeding work on a particular farm and the culture of running the dairy horse breeding industry as a whole. Russian heavy draft mares with an annual estimated milk yield of over 5,000 kg play an exceptionally important role in providing the herd with substitute young stock with high genetic potential. The studies were conducted at the koumiss breeding complex of the Semenovsky Breeding Plant CJSC in the Mari El Republic in the population of Russian heavy draft horses. On this farm, over 17% of mares had a milk yield of over 5,000 kg per lactation. The productivity and economic parameters of these animals were compared with the average for the population. The annual estimated milk yield of record-breaking mares ranged from 5,000 kg to 7,185 kg of milk. The mass fraction of fat and protein in record-breaking mares was slightly lower than the average indicators for the sample. At the same time, the amount of milk fat and milk protein was significantly higher in record-breaking mares than the average for the herd. The service period increased almost three times with an increase in milk productivity. The milk yield coefficient for the group of record-breaking mares was 856.50 kg, which was more than one and a half times higher than the same parameter for all mares of the enterprise. The lifetime milk yield of the selected mares was 1.8 times higher than the average similar parameter for the population. The record-breaking mares were characterized by high growth energy in all periods of ontogenesis. The age of the first successful insemination was 175 days less than the average for the sample.
Keywords: *horses, heavy draft horses, milk yield; milk fat content, milk protein content, service period, milk yield coefficient.*

INTRODUCTION
In the Russian Federation, dairy horse breeding develops actively, producing mare's milk and koumiss, a unique product that is a good nutritious product and a valuable remedy that improves the quality of life of people [1,2,3,4]. Mare's milk contains a large amount of unsaturated fatty acids necessary for human nutrition [5,6,7]. Mare's milk can be used as a substitute for breast milk [8] for infants [9,10,11,12,13]. Milk productivity of horses has been studied by a number of researchers [14,15,16,17,18,19,20,21,22]. According to many of them, the successful and profitable work of enterprises that produce mare's milk is determined by the level of breeding work with horses in dairy horse breeding. This is especially true when working with heavy draft horse breeds, which mainly have not been subjected to direct selection for increased milk productivity, but have high milk yield. The presence of record-breaking mares in the population of heavy draft horses indicates the presence of genes valuable for milk productivity in the gene pool of animals. Most often, the Russian heavy draft horse breed is used for milk production on stationary koumiss farms in Russia, as it is the most numerous breed in the country. Russian heavy draft horses are considered to be of small breed, however, according to Jansson A. [et al.], small horses produce more milk per unit of their weight than larger horses [15]. Horses of this breed are hardy, undemanding to feeding and maintenance conditions, and have high milk productivity. Russian heavy draft mares with an estimated annual milk yield of more than 5,000 kg play an exceptionally important role in providing the herd with substitute young animals with a high genetic potential for milk productivity [23]. Mares with record milk productivity should be characterized by certain economic and biological parameters, the study of which is of great scientific and practical interest.
The aim of this study is to determine the phenotypic characteristics of record-breaking mares of the Russian heavy draft breed.

MATERIALS AND METHODS

The research was conducted using the materials obtained from the zootechnical records of the Russian heavy draft mares in the koumiss breeding complex of the Semenovsky breeding plant CJSC, Medvedevo district, Mari El Republic. The sample included mares which were culled from the main herd of the complex from 1998 to 2020, a total of 213 heads. All animals were purebred and were assessed as the elite class. During the entire research period, the horses were kept in equally good feeding and housing conditions. The milk productivity of the animals was established on the basis of control milkings. The daily productivity of the mares was calculated using the Saigin formula:

$$Y_c = \frac{Y_T}{t} \times 24$$, where

Ус is mares' daily milk production, kg;
Ут is actual daily milk yield determined by the method of control milkings, kg;
"t" is the time mare spends in milking from the moment the foals are weaned until the end of the last milking, hours;
"24" is the number of hours in a day.
The estimated milk yield was also determined for months of lactation, for a full lactation, for 210 days of lactation and for a lifetime. In addition to milk yield, the mass fraction of fat and protein in the mares' milk was determined. Milk samples were collected in accordance with GOST 26809-85. The mass fraction of fat (MFF) in milk was determined in accordance with GOST 5867-90 - Milk and dairy products, the mass fraction of protein (MFP) in mares' milk was determined in accordance with GOST 23327-98 - Milk and dairy products.
The morphological properties of the mares' udder were assessed using the original method developed by E.D. Chirgin. The udder capacity was determined by the amount of milk produced after skipping one milking, when the mares' udder was filled to the limit in the 2nd-3rd month of lactation.
The duration of economic use (DEU) of mares was calculated from the beginning of the first lactation to the end of the accounting period or to the end of the mare's life in days. The percentage of failed impregnations was determined by dividing the DEU by the number of pregnancies during their entire life, multiplied by 365.
The first insemination of animals was carried out when the young mare reached a live weight equal to 80% of the weight of an adult mare, in the presence of regular estrous cycles.
Statistical processing of obtained data was carried out with generally accepted statistical methods on a personal computer using the Microsoft Excel 97 program.

RESULTS

Russian heavy draft mares in the horse population of the Semenovsky breeding plant CJSC were distinguished by high milk productivity - their estimated milk yield per lactation averaged 3,557.7 kg of milk. Among the total number of animals in the dairy herd of the farm, record-breaking mares with a milk yield per lactation of over 5,000 kg accounted for 17.37% (Table 1).

Table 1: Economic parameters of record-breaking mares in comparison with the average parameters for the herd

Parameters	Average per year	
	The whole sample (n=213)	Mares with estimated milk yield over 5000 kg of milk (n=37)
Estimated milk yield per lactation, kg	3557.70±40.92	5550.11±161.04**
Lifetime milk yield, kg	18089.74±208.05	32579.21±945.12**
Mass fraction of fat, %	1.85±0.02	1.67±0.05*
Milk fat, kg	65.82±0.76	92.69±2.69**
Mass fraction of protein, %	1.93±0.02	1.88±0.05
Milk protein, kg	68.66±0.79	104.34±1.20**
Service period, days	62.60±0.72	173.30±5.03**

Live weight of mares, kg	650±7.48	648±18.80
Milk yield coefficient, kg	547.34±6.29	856.50±24.85**

* P≤0.05; ** P≤0.01.

The estimated milk yield per lactation of record-breaking mares varied from 5,000 kg to 7,185 kg of milk, and generally its value exceeded similar average indicators for the herd by almost 2,000 kg of milk. The lifetime milk yield of mares with record milk productivity exceeded similar indicators of the milking herd by 1.8 times. The mass fraction of fat and protein in the milk of record-breaking mares was slightly lower than the average indicators for the sample and protein content differed slightly from the data of other researchers [24,25]. At the same time, the amount of milk fat and milk protein in the milk of record-breaking mares significantly exceeded the average indicators for mares in the entire milking herd. The duration of the service period in record-breaking mares was almost three times higher with increased milk productivity compared to the average indicators for the herd of milking mares, since the load on their organism increased significantly with the secretion of a large amount of milk.

As a rule, live weight plays an important role in the selection of animals for milk productivity. The record-breaking mares did not differ from other mares in their increased live weight in the studied population of mares of the Russian heavy draft breed. But the milk yield coefficient for the group of record-breaking mares averaged 856.50 kg, which was more than one and a half times higher than the same indicator for all mares of the enterprise. Consequently, the organism of the record-breaking mares produced milk one and a half times more efficiently compared to ordinary mares of the Russian heavy draft breed with a similar live weight.

We measured the udder of dairy mares, but the differences in udder measurements of mares with different milk productivity were small and statistically insignificant. Udder capacity, or the amount of milk that can be accumulated in the udder of mares, was more important characteristic of the milk productivity of animals. The physiological capacity of the udder of Russian heavy draft mares was 1.16-1.52 liters. And the maximum udder capacity of mares varied from 1.35 liters to 4.00 liters of milk. On average, the maximum udder capacity of Russian heavy draft mares was 2.54±0.04 kg of milk. And the maximum udder capacity of record-breaking mares varied from 3.00 to 4.00 kg of milk.

The correlation we calculated between the udder capacity and daily milk yield (+0.76) and the udder capacity and average one-time milk yield (+0.79) in Russian heavy draft mares indicated that the udder capacity largely determined the amount of milk yield in animals. These data confirmed the existence of a close relationship between the udder capacity of mares and their milk productivity. Consequently, the milk yield of mares was largely determined by the capacity of their udder and, accordingly, the amount of glandular tissue in the udder.

As a rule, record-breaking mares belonged to the most highly productive families [23]. Foals from high-milk mares differed from their peers in their high growth rate. Therefore, a comparative study of the growth energy characteristics of animals with different levels of milk productivity during the rearing period was of great interest (Table 2).

Table 2: Dynamics of live weight growth of Russian heavy draft mares with different milk productivity

Parameters	The whole sample (n=213)	Mares with estimated milk yield over 5000 kg of milk (n=37)
Live weight: at birth, kg	56.86±0.65	56.92±1.56
At 6 months, kg	280.36±3.20	314.47±8.62*
At 12 months, kg	378.68±4.32	434.07±11.90**
At 18 months, kg	449.80±5.14	515.17±14.12*
At first insemination, kg	527.41±6.02	528.43±14.48
At first lactation, kg	608.21±6.95	606.94±16.64
Age at first fertilization, days	749±8.56	574±15.73**

* P≤0.05; ** P≤0.01.

An analysis of the live weight growth rates of young horses demonstrated that the record-breaking mares were characterized by high growth energy during all periods of their ontogenesis. Thus, at the age of six months, their live weight was 34.11 kg or 12.17% greater than the herd average. At 12 months, the live weight of future record-breakers exceeded the live weight of their peers by 55.37 kg (14.63%), and at 18

months - by 65.37 kg (or 14.53%). Highly productive individuals of the Russian heavy draft breed were also distinguished by increased precocity of reproductive features; they reached sexual maturity earlier. The age of the first successful insemination was 175 days earlier than the sample average.

In the analyzed farm, it is customary to inseminate young mares for the first time when they reach a live weight of 520 kg, which is approximately 80% of the average weight of full-grown mares. Therefore, the live weight at the first insemination and at the first lactation in mares with different milk productivity were approximately the same.

The first insemination of Russian heavy draft mares at 1.5-2.0 years instead of 3.0 years, as is typical in horse breeding, is practiced in the studied farm, which allows to significantly improve the reproductive abilities of mares. In addition, we have shown that with early insemination the time for growing substitute mares is reduced by 1.5 times and the costs of their cultivation are reduced by 20-24%; the number of mares in the herd structure increases by 10-12%; the profitability of mare's milk and koumiss production increases, and the rate of selection of horses for milk productivity accelerates.

DISCUSSION

Mares with record milk productivity have high genetic potential. Their milk yield per lactation exceeds the average by 1.56 times. They have a longer service period, and, accordingly, their reproductive abilities are somewhat reduced. But ultimately, over their entire life, they produce 1.8 times more milk than the average level in the population. The organism of high-milk mares produces milk per kilogram of their live weight one and a half times more efficiently, as evidenced by the milk yield coefficient. Due to the high milk productivity of record-breaking mares, the growth rate increases and the development of reproductive abilities in their offspring accelerates. Milk productivity is influenced by many factors, such as the time of day [26] and types of higher nervous activity in mares [28]. But genetic factors have a significant influence on high milk productivity [27]. The greatest impact on the milk productivity of mares is exerted by their fathers - stud stallions [29]. Stud stallions also influence the development of morphological features of the udder of mares [29]. The heritability of udder parameters in Russian heavy draft mares was low, from 0.18 to 0.32, since the size of the udder does not always reflect the amount of secretory tissue in it. Udder capacity has a higher heritability coefficient. We believe that the maximum udder capacity is determined mainly by the genotype of the animal. The heritability coefficient of the maximum udder capacity of Russian heavy draft mares in the studied animal population was 0.65. In record-breaking mares of the Russian heavy draft breed, the heritability of this parameter was even higher - 0.88. This fact may indicate that the genotype of record-breaking mares of the Russian heavy draft breed contains a greater number of genes that determine the milk productivity of horses. Udder capacity also positively correlates with the duration of economic use of mares [30].

Therefore, we believe that during the selection process record-breaking mares accumulate a large number of genes in their genotype that determine the milk productivity of mares. Therefore, these animals reflect the high genetic potential of the milking herd and are of great importance for improving the productive and breeding qualities of animals, both in this farm and in the breed of Russian heavy draft horses as a whole.

CONCLUSION

1. The milk yield per lactation in record-breaking mares was 1.56 times higher than the average for the population.
2. The mass fraction of fat and protein in milk in record-breaking mares of the Russian heavy draft breed decreased.
3. The service period of high-yielding mares was almost three times longer (173.3) than the average for the herd (62.6).
4. Over their entire lives, high-yielding mares produced 1.8 times more milk than all mares on the farm on average.
5. The maximum udder capacity of record-breaking mares of the Russian heavy draft breed was one and a half times higher than the maximum udder capacity on average for the studied population.

6. The milk yield coefficient of record-breaking mares averaged 856.50 kg, which was also one and a half times higher than the average for the milking herd.
7. High-yielding mares of the Russian heavy draft breed were characterized by high growth energy during all periods of rearing.
8. The age of first insemination in high-producing mares decreased from 749 days to 574 days.

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