Genetic factor affecting the milk production of mares

E D Chirgin1, V G Semenov2*, A S Mokretsova2, D S Balitskaya2, E I Ustinova2, T L Davydova2, A A Vdovin2, A V Vasilyeva2 and U D Palagina2

1Department of Livestock Production Technology, Mari State University, 1 Lenin Square, 424000, Yoshkar-Ola, Russian Federation
2Department of Morphology, Obstetrics and Therapy, Chuvash State Agricultural Academy, 29 K Marx Street, 428003, Cheboksary, Russian Federation

*E-mail: semenov_vg@edu.academy21.ru, https://orcid.org/0000-0002-0349-5825

Abstract. The article presents the results of studies to establish the influence of the record productivity of mothers' mares on milk yield and the duration of productive life of mares-daughters of the Lithuanian heavy draft breed. It was found that the high level of milk productivity of mothers during the period of highest lactation (up to 4000 kg of milk) enabled their daughters to become leaders already during the first lactation. With an increase in the record milk yields per lactation in mothers, the heritability coefficient in mother-daughter pairs decreased and turned into negative values. The daughters of mares with record milk yields of up to 8000 are the most dairy among their contemporaries. The research results indicate that intensive milk production of mares during the first lactation can cause a reduction in the terms of their economic use due to the large loads on the developing fragile animal organism. The highest rates of productive life, number of lactations and life-long milk yield were obtained from daughters whose mothers had record milk yields per lactation from 7000 kg to 8000 kg of milk.

1. Introduction

The issues of dairy horse breeding have been studied quite well in areas of traditional Koumiss making (Kazakhstan, Russia, Kyrgyzstan, Mongolia) with herd keeping of local horses [1].

Scientific research and advanced experience of farms testify to the economic feasibility of developing horse breeding as a productive branch of animal husbandry to increase the country's food resources.

Scientists have proven that the level of milk production of mares depends on many factors, which can be divided into the following groups:

• genetic – breed, line, genotype and individual characteristics animals [2, 3];
• physiological – age, time of foal, stage of lactation, new fertility, peculiarities of the milk flow reflex [4, 5];
• technological – milking technique [6];
• feed – feed and feeding level [7, 8].

An important way to increase the efficiency of horse breeding is the intensification of the industry, the fullest use of horse productivity and the conduct of breeding work to increase the amount of products obtained. Much of the research done previously has focused on physiological and feeding factors. The question of the influence of the milk productivity of mothers on the productivity of mare daughters is critically little sanctified. It should be borne in mind that the widespread use of highly
productive animals in breeding work contributes to the accumulation of the most valuable genetic potential of mares, increases the possibility of obtaining even more highly productive breeding herds of horses. It has been established that mothers have a significant impact on the offspring, both during its prenatal development [9] and during the postnatal period of development [10]. Based on the foregoing, the goal of our study was to determine the relationship between the indicators of milk productivity of daughter’s mares, depending on the record milk yield of their mothers.

2. Materials and methods

The object of the study was mares-mothers and mares-daughters of the Lithuanian Heavy Draft breed. The research work was carried out on the livestock of mares of the Lithuanian Heavy Draft breed of the agricultural enterprise CJSC “Semenovsky” Breeding Plant (Mari El, Russia) for the period 2015-2019 (200 heads). The mares that participated in the experiment had from 1 to 22 lactations. The conditions of keeping and feeding the animals were the same all the time. The average live weight of the animals was 850 kg. Mares were kept in large groups of 12-14 heads on the grounds near the stables, and at night they were kept in a stable with a deep litter. The animals had constant free access to water and food. In the light time of the day – 16 hours – the mares were without foals. Milking was carried out every 2 hours, in total mares were milked 8 times a day. In the dark, the mares were together with the foals (8 hours) and the foals had the opportunity to suck the udders of their mothers.

Groups of mares were formed by the method of balanced groups depending on the highest productivity of mares-mothers: group I – milk yield for record lactation of mares-mothers less than 3000 kg of milk; group II – from 3000 to 3999 kg; group III – from 4000 to 4999 kg; group IV – from 5000 to 5999 kg; Group V – from 6000 kg to 6999 kg; group VI – from 7000 kg to 7999 kg and group VII – more than 8000 kg of milk. Daughters whose mother did not finish lactation were not taken into account. During the period taken to evaluate the indicators, the company used machine milking of mares, low-concentration type of feeding of mares of the dairy herd, a stall-walking system for keeping animals, a flow-shop system for moving animals through specialized workshops. In the population of Lithuanian Heavy Draft horses, only animals of the elite class are used. Mares were milked with DDA-2 milking machines at DDU-2 milking machines (Russia), located in milking parlors that were equipped in milk production workshops.

Machine milking of mares was performed by milking after stimulation of the udder by the foal to activate the milk release reflex. For this purpose, the milking machine provides a corral for the foal. The foal is allowed to approach one nipple, the second nipple is controlled by the milkmaid at this time. As soon as the active release of milk begins, the foal is removed from the udder, the udder is disinfected and a milking machine is put on. For milking, the DDA-2 milking machine (push-pull, dual-mode automatic), adapted to the mare's udder, is used. The average vacuum level is 45 kPa, the pulsation frequency is 120-140 cycles per minute. Milk yield was recorded using graduated measuring cylinders. Control milking was performed every 10 days.

The daily calculated milk yield of mares was determined by the formula of I A Saigin:

\[ Y_c = Y_d / t \times 24, \]  \( (1) \)

where, \( Y_c \) – estimated amount of milk in 24 hours, kg; \( Y_d \) – the actual amount of milk received per day, kg; \( t \) – the time period from the beginning to the end of milking mares during the day, hours; “24” – hours per day.

The calculated milk yield was also determined by the months of lactation, for full lactation, for the highest lactation, on average for all lactation, and the lifetime milk yield of mares was calculated. The duration of economic use of mares was calculated from the beginning of the first lactation to the culling from the milking herd.

All procedures were conducted according to the guide-lines for the ethical use of animals in applied animal behavior research on the protection of animals used for experimental and other scientific purposes.
The obtained results were processed by the generally accepted methods of variation statistics using the office software package “Microsoft Office” using the program “Excel”. The reliability of the difference between the indicators was evaluated by calculating the confidence criterion according to the Student's table, where: *P≤0.05; **P≤0.01; ***P≤0.001 when compared with the minimum values of the features.

3. Results and discussion
The question of the influence of the record productivity of mares-mothers on milk yield and the duration of productive life of mares-daughters of the Lithuanian heavy draft breed is investigated. Groups of mares were formed by the method of balanced groups depending on the record productivity of mares-mothers: group I – milk yield for record lactation of mares-mothers less than 3000 kg of milk; group II – from 3000 to 3999 kg; group III – from 4000 to 4999 kg; group IV – from 5000 to 5999 kg; group V – 6000 to 6999 kg; group VI – from 7000 to 7999 kg; group VII– from 8000 kg of milk and more (table 1). Daughters whose mother did not finish lactation were not taken into account.

Table 1. Impact of mares mothers 'record milk yield on their mares daughters' record milk yield.

| Record milk yield in groups, kg | Livestock, heads | Milk yield for the first lactation, kg | Milk yield for record lactation, kg | Heritability coefficient of record milk yield |
|--------------------------------|------------------|-------------------------------|-------------------------------|--------------------------------------|
|                                |                  | mother | daughter | mother | daughter |                                    |
| < 3000                         | 4                | 2525.00 | 2856.67* | 2525.00 | 4274.33 | + 0.66                                |
| 3000-3999                      | 16               | 2780.44 | 3552.63  | 3733.81 | 4812.31 | + 0.36                                |
| 4000-4999                      | 16               | 3889.69* | 3543.31  | 4509.94 | 4469.31 | + 0.41                                |
| 5000-5999                      | 33               | 3631.27** | 3743.94  | 5682.67 | 4718.21 | + 0.03                                |
| 6000-6999                      | 19               | 4032.79** | 3452.89  | 6405.95 | 5121.42* | - 0.14                               |
| 7000-7999                      | 5                | 5028.00 | 4922.40** | 7265.80 | 6373.80** | - 0.15                               |
| > 8000                         | 4                | 5048.00 | 4148.50* | 8576.00* | 4604.00 | - 0.48                                |

*P≤0.05; **P≤0.01

It was found that the high level of milk productivity of mares mothers during the period of the highest lactation (up to 4000 kg of milk) made it possible for their mares daughters to become leaders already during the first lactation at P<0.001. Productivity during the period of milking in mares-daughters of groups I and II was higher compared to their mothers. The record productivity of these mares was also higher than that of the mothers. The daughters of mothers with a record milk yield for lactation from 4000 kg to 6000 kg were distributed to approximately the same level as the mothers, their record milk yields for lactation differed slightly from the record milk yields of mothers. With an increase in record milk yields for lactation in mothers, the heritability coefficient in mother-daughter pairs decreased and turned into negative values. Obviously, the high milk productivity of mares required them to spend very high energy and nutrients to produce milk, which negatively affected the development of offspring [11]. In mothers with record milk yields for lactation of more than 6000 kg of milk, the daughters showed milk yield for the first lactation and record milk yields are lower than in mothers. But, despite this fact, the record milk yields of daughters grew and reached a maximum in the daughters of mares of the VI group (from 7000 to 8000 kg). In the daughters of mares of the VIII group, with record milk yields of more than 8000 kg of milk, productivity decreased sharply. Consequently, the daughters of mares with record milk yields of up to 8000 kg of milk per lactation are the most dairy among their peers. A similar trend was observed in the study of milk production of cows. According to Ukrainian scientists, the daughters of record-breaking red-and-white breed cows were characterized by a slightly higher productive duration than the herd average: the lifetime milk yield was higher by 10.4 and 28.9%, respectively, and the number of lactations in a lifetime was 6, 4 and 22.7%, respectively [12].

For dairy horses, as low-yielding and late-maturing animals, the duration of their productive life and life-long milk yield is of great importance. The dependence of these indicators in daughters on the record milk productivity of mothers is shown in table 2.
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Table 2. Impact of record maternal milk yield on productive life expectancy and lifetime milk yield of mothers and daughters.

| Record milk yield in groups, kg |Livestock, heads |Productive period, years |Number of lactations, pcs.|Lifetime milk yield, kg|
|---|---|---|---|---|
|< 3000 |4 |2.00**|mother|daughter|3025.00|25343.67|
|3000-3999 |16 |6.00|8.88*|mother|5.00|7.38|14520.75|29483.50|
|4000-4999 |16 |5.88|7.38|mother|4.88|6.31|17756.94|25025.13|
|5000-5999 |33 |12.27**|6.30|9.33**|mother|5.36|39905.61**|21754.61|
|6000-6999 |19 |13.47**|8.26|11.00**|mother|6.37|47672.12**|26105.16|
|7000-7999 |5 |6.20|10.60**|mother|4.60|9.60**|25824.00|46250.80**|
|> 8000 |4 |6.00|5.75|mother|6.00|4.75|24318.00|17550.75|

**P<0.05; **P<0.01

In absolute terms, the mares daughters were inferior to the mares mothers in terms of productive life expectancy, the number of lactations and lifetime milk yield.

In mares-mothers of the Lithuanian heavy draft breed, the maximum duration of productive life, the highest number of lactation and the highest lifetime milk yield were observed at record milk yields per lactation from 7000 kg to 8000 kg of milk. With the increase in record milk yields for lactation, all the considered indicators were decreased. The highest indicators of productive life, the number of lactation and lifetime milk yield were obtained from mares daughters whose mares mothers had record milk yields for lactation from 7000 kg to 8000 kg of milk. Thus, the results of the studies carried out showed a direct dependence of the mother's milk productivity on the record milk yield and the duration of the productive life of mare daughters, which coincides with the opinion on this issue when studying the correlation of these indicators of Holstein cows [13].

Many scientists, when predicting the productivity of animals, give the main role to linearity, while they do not take into account the qualitative indicators of the milk productivity of mothers, the results of our studies provide a basis for breeding according to this indicator in order to improve the industry of dairy horse breeding [14, 15].

4. Conclusion

With an increase in the record milk yields for lactation in mares mothers from 3000 kg to 8000 kg of milk, the record milk yields for lactation in their daughters are increased.

The maximum duration of productive life and the highest lifetime milk yield was observed in mares daughters whose mares mothers had a record milk yield for lactation from 7000 kg to 8000 kg of milk.

It is not necessary to distribute mares to record milk yields for lactation of more than 8000 kg of milk, since at the same time the mares daughters of this mares mothers have a sharply reduced milk productivity.

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**Table 2.** Impact of record maternal milk yield on productive life expectancy and lifetime milk yield of mothers and daughters.
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