Influence of the type of higher nervous activity on milk yield and the productive longevity of mares

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Abstract. The presented work is the result of studies of the influence of the type of higher nervous activity on the dairy productivity of mares of the Russian heavy draft horse breed on stationary koumiss farms. To determine the types of higher nervous activity, a motor-food technique developed by the All-Russian Research Institute of Horse Breeding was used. The milk yield was counted at animals for the first lactation, for the highest lactation, on average for one lactation and a lifelong milk yield of mares. The milk yield on average for lactation is almost the same in mares with a strong balanced mobile type and with a strong unbalanced type of higher nervous activity. Animals of a weak type and a strong balanced inert type of higher nervous activity lag behind them in this indicator by 11-13%. Horses with a strong balanced mobile type, a strong unbalanced type and a weak type of higher nervous activity are most suitable for the duration of economic use and lifelong milk production. The mares with a strong balanced inert type of higher nervous activity are the least productive in terms of duration of economic use and lifelong milk yield on koumiss farms.

1. Introduction

In the Russian Federation, large highly mechanized enterprises with modern production technology are being built in dairy horse breeding, capable of ensuring the production of high-quality products with minimal labor costs. Mechanized milking of mares provides more milk of better quality compared to manual milking [1].

However, a reduction in labor costs, feed costs and high capital costs on highly mechanized complexes can only be obtained by taking into account and as fully realizing the biological characteristics of animals as possible. In the Russian heavy draft horse breed, work is underway to develop a specialized dairy type [2].

Breeding and selection based on the body's high genetically determined resistance to stress is one of the most important ways to improve the breeds and lines of horses in dairy horse breeding in order to be suitable for the requirements of modern intensive animal husbandry. Breeding and selection of animals for their resistance to stress contributes to an increase in milk productivity as well. The basis of this technique is the physiological regularity of the connection of types of the higher nervous system of animals with the reactivity and stress resistance of their body. Most stress-resistant horses
are animals of a strong balanced mobile type of the nervous system, the strength and mobility of the nervous processes of which, causing a higher reactivity to stimulating and low to inhibitory effects of the medium, provide them with a high intensity of the milk recovery reflex and the completeness of milk release from the udder. Stresses, inhibiting the growth processes, reproductive and lactational functions of animals, reduce the reproduction of horses and all types of their productivity, including dairy productivity. The organism of horses on dairy farms is subjected to various stressful effects: adverse environmental conditions, veterinary and preventive and zootechnical measures, insufficient, excessive or inferior feeding, injuries and diseases [3-5].

So, with various diseases and injuries in horses, the concentration of serotonin in the blood decreases while simultaneously increasing adrenaline and noradrenaline levels [3]. Which, in turn, negatively affects the milk productivity of animals. In addition, in various diseases, mares show an increase in the level of testosterone in the blood, which reduces their reproductive function [6]. And with a decrease in the fertility of mares, their dairy productivity, especially lifelong, also decreases. For horses, as infertile and late-ripening animals, lifelong milk productivity is of great importance [7].

In most cases, with short-term stress in horses, the sympathoadrenal system is activated, as a result of which catecholamines (adrenaline, noradrenaline, dopamine) are formed [3]. But the level of these hormones in mares can be increased not only as a result of stress, but, for example, during foals [8]. This is due to a decrease in the level of milk yield in lactating foal mares.

Stress-related responses have been associated with an increase in the activity of the hypothalamic-pituitary-adrenocortical (HPA) axis, adrenomedullary system and autonomic nervous system (ANS) in horses. The activity in which adult horses are involved appears to have an influence on their behavioral and physiological responses to different stimuli, and thus affects the welfare of horses. Understanding this influence is of great interest for improving equine welfare, with the aim of habituating and/or desensitizing horses to disturbing stimuli [9].

With prolonged stress exposure, an increased content of glucocorticoids is observed in the blood, among which cortisol plays a leading role in horses. An increase in the concentration of cortisol in the blood during estrus as a result of various stress factors is considered one of the main reasons for a decrease in the reproductive function of mares [3, 4, 10, 11]. The reproductive function of mares indirectly affects their milk productivity. Under the influence of stress associated with the socialization of new horses in the herd, the amount of bound cortisol decreases in animals with a simultaneous increase in free cortisol in the blood, which also negatively affects the fertility and milk productivity of mares [12]. Therefore, from the beginning to the end of lactation, it is not recommended to change the composition of technological groups in milking herds.

The basis of all these processes is the physiological pattern of the connection of types of the higher nervous system with the reactivity and stress resistance of the body. The individual ability of horses to adapt and their body's resistance to stress are due to the genetically determined properties of the nervous system, that is, the type of nervous system. Animals with strong and mobile nervous processes - belonging to a strong balanced mobile type of higher nervous activity - have the highest resistance to physical and emotional stress. The greatest predisposition to stress are animals with weak, inert nervous processes - horses of a weak type of the nervous system. The resistance or predisposition to stress is based on the different reactivity of animals of various types of the nervous system to the inhibitory effects of the environment [13].

I P Pavlov emphasized the high plasticity of the central nervous system, investigated the complex functional systems within the brain and between the organism and its environment, and designed models for pathological deviations of the higher nervous activity [14].

Of the many methods developed to determine the stress sensitivity of animals, unfortunately, almost none are used in horse breeding. Therefore, methods are used to determine the types of higher nervous activity of horses.

The purpose of our research was to identify and evaluate the relationship between the type of higher nervous activity of horses of the Russian heavy draft breed with their dairy productivity, duration of economic use and life-long milk yield.
2. Materials and methods

The study involved 80 mares of the Russian heavy draft breed. All of them were randomly selected from a large herd (CJSC breeding plant “Semenovsky”, Republic of Mari El, Russia). 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. Their average live weight was 630 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 h – the mares were without foals. Milking was carried out every 2 h, a total of mares were milked 8 times a day. In the dark, the mares were together with the foals (8 h) and the foals had the opportunity to suck the udders of their mothers. Mares were milked on the milking platform, in the DDU-2 milking machine. Machine milking of mares was performed by milking after stimulation of the udder by the foal to activate the milk ejection 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 by means of 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:

\[ P_d = \frac{U_d}{t} \times 24, \]

where, \( P_d \) – estimated milk productivity for 24 h, kg; \( U_d \) – how much milk is needed per day, kg; \( t \) – the time period from the beginning to the end of milking mares during the day, h; “24” – h/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.

The type of higher nervous activity in mares was determined using the motor-food technique developed by the All-Russian Research Institute of Horse Breeding (ARRIHB). This technique uses natural food irritants and determines the reaction of horses to them.

The objectives of the research were to identify the relationship between different types of higher nervous activity with average milk yield per lactation, for the first lactation and the highest milk yield per lactation; with productive longevity and lifetime milk yield. Identification of the preferred type of higher nervous activity in the study population and the most desirable type of higher nervous activity in the production of mare's milk. According to the main properties of the nervous system, that is, the combination of the strength of the processes of excitation and inhibition, their balance and mobility, horses were assigned to one of the types of nervous activity described below according to the classification developed by I Pavlov.

Strong balanced mobile type. In horses of this type, the processes of excitation are equally equalized by the processes of inhibition. Horses are agile and well-behaved, easy to handle, pliable in work, obedient and calm. They quickly recover after a short rest. This is the most desirable type of higher nervous activity.

Strong balanced inert type. The processes of inhibition of this type prevail over the processes of excitation. Horses are well-behaved, very calm, but in an unfamiliar environment they are timid, they are obedient and easy to handle. Inertia manifests itself in a slower development of conditioned reflexes. The ability to work in these horses also recovers slowly.

Strong unbalanced (unrestrained) type. The processes of excitation of this type prevail over the processes of inhibition. Horses are “strict” in their treatment, good-natured with a good attitude towards them. A little nervous at work, sometimes timid, angry, excitable, excessively hot, vindictive. They often have an unbalanced psyche, show an aggressive and defensive reaction, have an easily excitable temperament, and are not very easy to handle.

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Weak type. Horses often refuse to work, are disobedient, angry, nervous, timid. They have poorly developed processes, both excitation and inhibition. They are not suitable for any type of work. All procedures were conducted according to the guide-lines for the ethical use of animals used for experimental and other scientific purposes. The results obtained were processed by conventional methods of variation statistics using the Microsoft Office software using Excel.

3. Results and discussion

Studies were carried out to determine the types of higher nervous activity among mares of the Russian Heavy Breed. All animals participating in the studies (80 heads) were divided into four groups by belonging to the corresponding types of higher nervous activity:

1. strong, balanced, mobile;
2. strong, unbalanced;
3. strong, balanced inert;
4. weak type.

Most of the mares of the farm belonged to the first type of higher nervous activity - 49 heads or 61.25%. The least animals belonged to a strong unbalanced type - 7 heads or 8.75%. 11 mares or 13.75% belonged to the second type of higher nervous activity and 13 mares or 16.25% belonged to the fourth (weak) type of higher nervous activity.

The relationship between dairy productivity and types of higher nervous activity is shown in table 1.

Table 1. Relationship of dairy productivity of mares with types of their higher nervous activity.

| Indicators                          | Types of higher nervous activity |
|-------------------------------------|----------------------------------|
|                                     | 1                  | 2                  | 3                  | 4                  |
| Milk yield for the first lactation, kg | 3213.92           | 3111.55           | 2901.14*           | 2776.92**          |
| Milk yield for the highest lactation, kg | 4265.58           | 4594.55           | 4032.57           | 3711.77**          |
| Milk yield on average per lactation, kg | 3422.57           | 3396.89           | 3080.23**          | 3021.29*           |

* P<0.05; ** P<0.01.

The largest number of mares for milk yield for lactation above 5000 kg belonged to 2 types of higher nervous activity – 36.37%, they also had the highest record milk yield for lactation. Among the animals of the first type, there were 27.09% of such record mares, among the third type of higher nervous activity – 14.29%. Among mares of a weak type of animal with milk yield above 5,000 kg was not at all. The average record productivity of milk yield in the second group was the highest and amounted to 4594.55 kg, which was 328.97 kg (7.72%) more than in the first group, 561.98 kg (13.94%) more than in the third group and 882.78 kg (23.79%) more than in the fourth group.

On average, milk yield per lactation is almost the same in the first and second groups. The mare of the third and fourth groups are behind them in this indicator by 11-13%.

In mares with a predominant excitation process (the second type of higher nervous activity), positive conditional reflexes are easily and quickly produced, and brake reflexes, on the contrary, are difficult produced. Mares should be trained to milking with a minimum number of distractions, gradually developing inhibitory skills for the manifestation of strong external stimuli. In this case, these mares may have high milk yield, they, oddly enough, have almost no disruptions and neurosis. However, their memory is not as good as that of phlegmatics and sanguines, so milking skills, which have not been repeated for a long time, can fade and be forgotten. Therefore, on average, they have less milk yield per lactation (for the entire period of their life) than mares of the first type of higher nervous activity.

Mares belonging to the first type of higher nervous activity are most adapted to receive milk from them. They quickly develop conditional reflexes, they can, if necessary, be quickly retrained, they are most resistant to stressful factors. They are somewhat inferior to animals of the second type in record
productivity, but they have the highest milk yield on the first lactation and are almost the same as the second group on average per lactation.

Horses with insufficient mobility of nervous processes (the third type of higher nervous activity) are hard to tolerate a quick change in arousal and inhibition, slowly (compared to other horses) learn to milking, with difficulty to change and redesign the skills that they form relatively slowly. Subsequently, such horses are usually well reached to the end of lactation. Due to the fact that such horses remember once learned skills very well and for a long time, mistakes in their training should be avoided: retraining will be very difficult. The reaction to stressors in these horses does not appear immediately, with a lag, but lasts longer.

The weakness and immobility of nervous processes in mares of a weak type of higher nervous activity makes them very sensitive to any stimuli, and strong stimuli cause inhibition of conditionally reflex activity. They need to be accustomed to stimuli of various forces gradually, to provide rest in any manifestations of braking. With painstaking work, high rates of dairy productivity can be achieved, but not stability and reliability. For mares, as for late-ripe animals, the duration of economic use and lifelong milk yield are of great importance (table 2).

Table 2. Relationship of higher nervous activity types with productive life expectancy and lifetime weight.

| Indicators                      | Types of higher nervous activity |
|--------------------------------|---------------------------------|
|                                | 1    | 2     | 3    | 4     |
| Duration of economic use, years| 9.38 | 8.82  | 7.86* | 8.77  |
| Lifetime milk yield, kg        | 26036.73* | 24227.82 | 20164.57 | 22328.00 |

* P<0.05.

For both indicators considered, the first group mare with a strong, balanced, mobile type of higher nervous activity had an advantage. The second place in terms of the studied signs belonged to the second group, 0.56 years (6.35%) less was the duration of economic use and 1808.91 kg (7.47%) lower than lifelong milk yield. The third place was taken by mare of the fourth, weak type, their period of productive life and lifelong milk yield were inferior to the first group, respectively, by 0.61 (6.96%) years and by 3708.73 (16.61%) kg. Obviously, painstaking work with the animals of this group brought its results. The lowest indicators for the duration of economic use and lifelong milk yield were in animals of the third group (a strong, balanced inert type of higher nervous activity), they were inferior to the leaders, respectively, by 1.52 (19.34%) of the year and by 5872.16 (29.13%) kg of milk. Overstraining the processes of arousal or mobility of nerve processes leads horses of this group to lethargy, depressed state and, ultimately, to a reduction in the period of their productive life and a decrease in lifelong milk yield.

The types of higher nervous activity of mares of the Russian Heavy Breed have a significant impact on their milk productivity. For the production of milk on stationary koummiss farms, horses with a strong balanced mobile type of higher nervous activity are most suitable. The least productive are mare with a strong balanced inert type of higher nervous activity. If you have proper milking training, you can use mares with a strong unbalanced type of higher nervous activity and with a weak type of higher nervous activity.

4. Conclusion
1. The highest record milk productivity is achieved by mares of a strong unbalanced type of higher nervous activity.
2. Mare of weak type and strong balanced inert type of higher nervous activity have the least milk yield on average per lactation.
3. Animals with a strong balanced mobile type of higher nervous activity have the highest milk yield for the first lactation, on average for one lactation, the longest duration of economic use and the highest lifelong milk yield.
4. Horses with a strong balanced mobile type, a strong unbalanced type and a weak type of higher nervous activity are most suitable for the duration of economic use and lifelong milk production on stationary koumiss farms.

5. The mares with a strong balanced inert type of higher nervous activity are the least productive in terms of duration of economic use and lifelong milk yield on koumiss farms.

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