Stress tolerance and productive longevity of cows with intensive milk production technologies

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Abstract. The studies were carried out on black-and-white cattle of the Ural intra-breed type, bred at the enterprises of the Sverdlovsk region. The studied groups of animals are formed depending on the milking technology (milking in a milk pipe, in milking parlors, robotic milking). The level of hormones in the groups of cows, where intensive milking technologies were used, is higher than in the groups of linear milking in the milk pipeline: prolactin by 17.2 ng / ml; adrenocorticotropic hormone by 10.3 pg / ml; cortisol by 5.3 nmol / l. The number of heifers with a high type of stress tolerance is on average 6.3% less in groups where intensive milking technologies were used in comparison with linear milking in a milk pipe.

1 Introduction

Dairy farming is still one of the main and promising branches of animal husbandry in our country. In recent decades, the industry has undergone major changes in the technology of feeding and keeping livestock, milking and processing raw materials. Many enterprises have switched to intensive technologies, which include year-round loose stall keeping of dairy cows in complexes, milking in automated milking parlors or with the help of milking robots [1-4].

At the same time, it is in the conditions of intensification of production that the volumes of products obtained increase, which requires great attention of specialists regarding the quality of dairy raw materials. In addition, there is a real problem of reducing the terms of productive longevity of dairy cows when using intensive milking technologies. Scientists and practitioners in our country and abroad are looking for effective ways to extend the period of production use of dairy cows. Numerous studies are devoted to this direction [5-8].

Researchers believe that one of the ways to increase the indicators of productive longevity in cattle is to reduce the degree of exposure of animals to stress factors of various origins [9-15].

The classical definition of stress was given back in 1971 by G. Selye "... the body's nonspecific response to any impact." In the process of studying this issue, the scientist repeatedly clarified this concept, and a decade later the formulation was as follows: "a set

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of stereotyped, phylogenetically programmed nonspecific reactions of the body, which are caused by any strong, superstrong influences and are accompanied by a restructuring of the body's defenses." At the same time, according to A.I. Afanasyeva, the most capacious definition of stress was given in 1980 by the scientist F.I. Furdui: "Stress is a set of nonspecific reactions of the body in response to the action of extreme stimuli of various nature and character, causing tension in the function of organs and systems and providing mobilization of the body in order to adapt it or maintain homeostasis." Consequently, stress acting on an animal's body is a multifactorial concept [16].

Stress factors in dairy farming include the conditions of feeding, milking, housing, zoohygienic, natural and climatic factors, etc. The predisposition to stress, like other characteristics of the animal organism, most likely can be both a breed characteristic and be dependent on production conditions [17, 18].

The aim of the research was a comparative study of stress resistance and indicators of productive longevity of Ural-type black-and-white breed with intensive milk production technologies.

2 Material and methods

The research was carried out on the basis of two breeding enterprises of the Sverdlovsk region, specializing in cattle breeding. The object of research was first-calf cows of the Ural intra-breed type of black-and-white breed. The work used notes of individual cards of cows, milk logs, data of the information and control system "SELEX".

The level of stress resistance of the studied animals was determined by the results of assessing their hormonal levels during the period of milk production of the first lactation. Blood was taken from the jugular vein in the morning, two samples were taken from each animal, and the average value was taken for the result. The content of hormones in the blood serum of cows was determined in a clinical diagnostic laboratory (Tyumen) by an enzyme immunoassay using kits from the company "Alkor Bio" (St. Petersburg).

At the same time, the evaluated animals were divided into groups according to the scheme presented in Figure 1. First-calf heifers were analogous by the date of the last calving, live weight.

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Milking technology	1. Milking in milking parlors (enterprise 1)	control Group	milking into the milk pipe with DA-2M "Maiga" machines, tied up housing, n = 350
		experienced Group	milking machine "Europarallel", yard housing, n = 350
	2. Robotic milking (enterprise 2)	control Group	milking into the milk line with DA-2M "Maiga" machines, tied up housing, n = 24
		experienced Group	milking by the Lely Astronaut A4 robotic milker, yard housing, n = 24

Fig. 1. Research scheme.

Each study group consisted of clinically healthy animals under the same feeding conditions, in the same physiological state. The studied groups of animals were fed rations that were used at enterprises and were calculated by specialists taking into account the live weight of cows, lactation period, milk yield per day, mass fraction of fat in milk and physiological state.

The assessment of breeding and productive qualities of the studied animals was carried out in accordance with the "Procedure and conditions for assessing pedigree cattle of dairy

and milk-and-meat productivity" (approved by order of the Ministry of Agriculture of the Russian Federation No. 379 dated October 28, 2010), with the "Rules keeping records in livestock breeding of dairy and dairy-meat productivity "(approved by order of the Ministry of Agriculture of the Russian Federation No. 25 dated 02/01/2011, as amended on June 10, 2016). The processing of research results was made in the programs "Microsoft Excel", "Biostatistics" with the calculation of the main statistical and biometric indicators. The level of reliability of the difference between the groups according to the characteristics was established using the Student's test. Thresholds of statistically significant differences: * - p <0.05; ** - p <0.01; *** - p <0.001.

3 Research results

Evaluation of the hormonal background of cows showed (table 1) that when comparing linear milking and milking in milking parlors, the prolactin level in the experimental group is higher by 20.65 ng / ml (12.5%) (p <0.001) compared to the control. Serum adrenocorticotropic hormone was also found to be higher in animals milked in milking parlors by 12.41 pg / ml (13.1%) (p <0.001). The level of cortisol in cows during milking in a milking machine is 5.63 nmol / l (14.6%) (p <0.001) higher than in animals milked using a milk pipe.

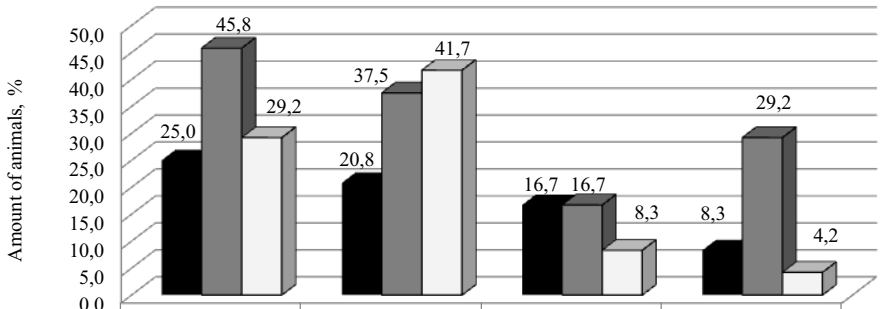
Table 1. The content of hormones in the blood of first-calf cows of the black-and-white breed, $\overline{X} \pm S_{\overline{X}}$

Indicator	Group of cows, milking technology			
	control, milking in a milk pipe, tied up housing	experienced, milking machine "Europarallel", yard housing	control, milking in a milk pipe, tied up housing	experienced, robotic milking, yard housing
Prolactin, ng / ml	144,2±2,6	164,8±2,6***	155,9±2,9	169,6±3,6**
Adrenocorticotropic hormone, pg / ml	82,3±1,4	94,8±1,6***	88,9±1,5	96,9±2,4*
Cortisol, nmol / l	32,9±0,2	38,5±0,2***	34,2±0,2	39,1±0,3***

Note: hereinafter * – p < 0,05; ** – p < 0,01; *** – p < 0,001;

Comparative assessment of hormone content during robotic and linear milking of cows showed that the content of prolactin in the blood serum of cows in the experimental group is 13.7 ng / ml (8.1%) (p <0.01) more than in animals of the control group. The amount of adrenocorticotropic hormone in the body of cows milked by a robotic milker is 8.0 pg / ml (8.3%) higher than in animals of the control group (p <0.05). The amount of cortisol in animals of the experimental group is also higher than in the control group of the evaluated cows by 4.9 nmol / l (12.5%) (p <0.001).

All cows tested for hormones were conditionally distributed in each group according to the level of stress resistance. The results are shown in Figure 2.



	control group, milking in the milk pipeline	experienced group, milking in milking parlors	control group, milking in the milk pipeline	experimental group, robotic milking
high	25,0	20,8	16,7	8,3
medium	45,8	37,5	16,7	29,2
low	29,2	41,7	8,3	4,2

Fig. 2. Distribution of first-calf heifers of black-and-white breed by types of stress resistance, %.

It was found that there were more heifers with a high type of stress resistance in the control groups of animals - by an average of 6.3%. At the same time, cows of the average type of stress resistance in the total share of the studied animals occupied from 29.2 to 45.8%.

A low type of stress resistance is more typical for the group of cows that were milked in milking parlors (41.7%). The difference with the control group of animals in this case was 12.5%.

It should be noted that in a comparative analysis, first-calf heifers of a low type of stress resistance accounted for only 4.2% in the group of cows with robotic milking, which is 4.1% less than in the control group. This fact makes it possible to believe that first-calf heifers are better adapted to milking conditions by a robotic milker.

However, with a high level of stress resistance, there are 8.4% more animals in the control group of animals, where milk pipelines were used, in comparison with the experimental group. Consequently, there is a need, when selecting cows for milking in high-tech milking installations, to include in the assessment indicators the level of stress resistance of animals.

Let us assume that the intensive use of animals (including in high-tech milking installations) leads to a reduction in the period of production use of animals.

In our studies (table 2), when milking in a milk pipe, animals produced products for a longer period - 0.9 lactations longer than cows that were milked in milking parlors ($p < 0.001$); 0.2 lactation longer - compared to cows with robotic milking ($p < 0.001$).

Table 2. The period of productive longevity and lifetime milk production of cows, $\overline{X} \pm S\overline{x}$

Indicator	Group of cows, milking technology			
	control, milking in a milk pipe, tied up housing	experienced, milking machine "Europarallel", yard housing	control, milking in a milk pipe, tied up housing	experienced, robotic milking, yard housing
The period of productive longevity, lactation	3,2±0,05***	2,3±0,05	2,2±0,1***	2,0±0,07
Life milk yield, kg	25451,0±509,3***	19741,0±461,2	11268,0±505,9	13150,0±494,0**
Milk fat, kg	1006,6±20,0***	790,6±18,1	423,5±18,9	486,1±18,7*

Milk protein, kg	802,5±16,0	626,5±14,6	339,3±15,3	403,8±15,4**

Due to a longer life span, cows that were milked in a milk pipe produced more milk than animals when milking in a milking parlor (by 5710.0 kg (22.4%) at $p < 0.001$). At the same time, the analysis showed superiority in milk yield over the life period of cows that were milked by a robotic milker over animals of the control group (by 1882.0 kg (14.3%) at $p < 0.01$).

A similar situation was observed in relation to the indicators of the amount of milk fat and protein in the cows of the studied groups. So, the content of milk fat and protein in cows of the control group is more by 216.0 (21.5%) and 17.6 kg (21.9%), respectively, in terms of indicators than in the group of animals that were milked in dairy halls. At the same time, the lifelong content of milk fat and protein is higher in the group of robotic milking of animals in comparison with the control group, respectively in terms of indicators by 62.6 kg (12.9%) ($p < 0.05$) and 64.5 kg (15.9%) ($p < 0.01$).

Thus, the duration of the economic use of the studied cows depends both on the milking technology and on the housing system, which in turn was reflected in the level of stress resistance of animals.

In general for the herd, the main reasons for the withdrawal of animals were: diseases of the udder (14.3 - 25.7%), diseases of the digestive system (9.4 - 15.1%), metabolism (9.7 - 16.0%), diseases of the legs (8.9 - 10.0%). Analyzing the reasons for the retirement of animals to which various technologies for obtaining milk were applied, it was found that due to low milk productivity, the animals that were milked in a milk pipe and kept on a leash were rejected more often by 7.2%. Cows of the same group dropped out of the herd more often than cows in the control group, due to udder disease (by 11.4%) and gynecological diseases (by 3.0%), metabolic diseases (by 6.3%). Animals kept without a tether were rejected from the herd due to rupture and sprains of ligaments, diseases of the digestive system, barrenness, accidents and injuries more often than cows of the second group, respectively, in terms of indicators by 4.2; 5.7; 4.3 and 1.1%.

4 Conclusions

1. The level of the evaluated hormones in the groups of cows, where were used intensive milking technologies, is higher than in the groups of linear milking in a milk pipe ($p < 0.001$): prolactin by 17.2 ng / ml; adrenocorticotropic hormone by 10.3 pg / ml; cortisol by 5.3 nmol / l.
2. The number of heifers with a high type of stress tolerance is on average 6.3% less in the groups where intensive milking technologies were used. There is a need, when selecting cows for milking in high-tech milking installations, to include in the assessment indicators the level of stress resistance of animals.
3. A low type of stress resistance is more typical for a group of cows that were milked in milking parlors - 41.7% of the total number of studied animals. The first-calf heifers adapted better to the milking conditions by the robotic milker, since the number of animals with a low type of stress tolerance was 4.1% less than in the control group.
4. When milking in a milk pipe, the productive longevity of groups of animals is on average 0.6 lactations ($p < 0.001$) longer than in cows that were milked using intensive technologies. At the same time, the life-long milk yield of cows when milking by a robotic milker is 14.3% ($p < 0.01$) higher than in a group of animals that were milked into a milk pipe.

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