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Biological And Ethological Characteristics Of Simmental Heifers And Cows Under Effects Of Intensive Technologies.

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ABSTRACT

The problems for the modern Simmental breed, associated with the protracted process to increase the cow milk production, which is generally provoked by the long-term and unsystematic use of the Holstein bulls, have been emerged. It resulted in the loss of the offspring valuable properties and homogeneity in the genealogy, therefore, causing the need to improve the current Holsteinized population of the Simmental cattle with the use of the Montbeliard bulls known to have a common origin with the Simmentals. The experiment with the Montbeliard bulls used in the Simmental breeding stock was performed in the Central Federal District, Russian Federation from 2013 to 2018. Ethology as the study of behavior in the offspring of new genotypes was applied, since the comprehensive survey for their vital functions under any conditions of keeping is essential in order to make the best use of the animals with regard to the behavior as the feature of the organism, caused by both the environmental factors and the inheritance. The novelty of the survey is in the fact that the Montbeliard bull semen has been used in the Russian Holsteinized Simmental breeding stock, which is characterized by the herd average milk yield of more than 7.0 thousand kg per cow. Ethology as the study of behavior is applied. The live weight and the milk yield in the produced offspring of different genotypes, reared under the effects of the intensive technologies, are analyzed. It has been ascertained that the most expressed behavioral responses in the animals of the analyzed genotypes are the feeding patterns. The developing animals consume the feeds with 10-14 feed intakes. The significantly highest rate of the feed intake was typical for the 8-9 month old heifers produced from the Montbeliard bulls. Thus, their total daily feed intake took four hours, since the duration of a single feed intake (for 18.4 minutes) was 2.9 minutes shorter. The Montbeliard blood first-calf heifers acquiring the feeding activity index (FAI) at 56.9% spent less time for feed intake and rumination by 6.6% and 2.7%, respectively, when compared to that in their first-group peears acquiring the FAI at 60.6%. With respect to the motion activity, the greater difference between the cows of two genotypes was recorded; the standing time for the Montbeliard bull offspring was more by 7.1%, while the lying time was 7.1% shorter, than that in their peers with ¾ of Holstein blood. The production-system group dependence index for the Montbeliard bull cows was practically two times higher (25.4%), than that in the peers with ¾ of Holstein blood (14.2%); the index value was generally affected by the time for keeping the cows in a holding yard before their milking. The cows produced from the Montbeliard bulls are even-tempered; they express sociability and groming and allogrooming behavior. The live weight of the Montbeliard blood heifers was 9.0..14 kg more than that in their peers with ¾ of Holstein blood in the analyzed periods. The average daily milk yields in the cows at the 3^{d}-4th months of lactation in both groups comprised 25.1 kg and 25.6 kg, respectively.

Keywords: Simmental, Montbeliard, and Holstein breeds, genotypes, ethology, animal behavior, love weight, milk yield

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INTRODUCTION

The Simmental cattle population ranks third in the total number of the bovine livestock in Russia. Its specific gravity in the dairy cattle structure comprises 7.09% [1]. In the 1990s of the last century, the Simmental breed was the top breed in the country. Within the breed, there were the herds with the milk yields at the level of six thousand kilograms per cow a year [2]. A sharp reduction in the size of the Simmental cattle population from 1990 until the present time can be partially explained by both the use of the Holstein bulls over this breed cows and the intensive increase in the Holsteins in our country. Morover, a large-scale popularization of this breed compared to the other breeds in the milk yield can contribute to this process.

In addition, the rational use of the Holstein bulls might have a positive effect on the consolidation of the Simmental offspring of a dairy type, the cow's udder quality, the milk production, and the technological characteristics [3, 4, 5, 6]. However, long-term and unsystematic using the bulls of the improving breed in the Simmental breeding stock caused the lack of beaf properties, adaptatve mechanisms to the natural environments and the climate zones, and resistance to diseases in the offspring. It could do a lot worse to the body conformation traits, affect the productive lifetime, and decline the reproductive performance (7). Many recessive lethal mutations revealed in the Holstein cattle had the adverse effects on the domestic herds. It is quite problematic, since the genealogy of the Holstein cattle is **highly homogeneous** [8].

In addition, the modern dairy cow farming business specified to a long-term process of improving the milk production in most countries of the world has faced the problems associated with the technical progress accelerating this trend through the opportunities in selective breeding and zoo-technical engineering. The livestock systems targeted for high production efficiency tend to keep the cattle under the conditions extending far beyond the natural environments. At the modern dairy complexes, approximately all the living conditions are modified by humans with the keeping, feeding and milking technologies, the standards for the group size, sex behavior, etc. [9].
Therefore, one of the major prerequisites for successful intensive animal farming is the knowledge of the vital activities of the farm animals kept under any environmental conditions. A natural science known as ethology is focused on the mechanisms of this type. In order to reduce the negative effects of the intensive milk production, it is relevant to know the nuances of the animal behavior with respect to the fact that a behavior is a property of the organism, caused by both the impact of the external environments and the inheritance. A research into the animal behavior assumes revealing the relationships between the behavior and the various events and processes, which precede a certain behavior pattern, and therafter accompany and follow it [10]. Behavioral ethology allows us to understand the importance of the adaptive behavior under the motivations of the animal behavior, regulated by both its physiology and the responses to the effects of the environment.

Behavior as a function of a certain unconditioned reflex has a genetic basis. The efficiency of selection for the behavioral traits with the ethological approaches proves the genetic reason for some major behavioral patterns. According to the genetic researches, the innate part of behavior comprises approximately 50% of all the elements of behavior of higher mammals, while 70% of the social behavior is caused by the animal genotype [11, 12].

The animal behavior patterns characterize the habitat-specific-morphology caused by both the animal functional anatomy and the genotype. It is well known that the cattle of some breeds can be more aggressive than the other animals and dominant over them [13]. The scientists' survey materials [14, 15, 16, 17] prove the association of it with the dairy cow motion activity.

However, improvement of the milk production efficiency and realization of the cow genetic potential significantly depend on well-organized animal rearing. Therefore, the attention should be drawn to rearing the cattle replacement youngstock in the period of developing the anatomical and physiological processes in the organism [18]. A transition phase as a period between 1-1.5 months and 4-6 months of age has been first defined within the cattle postnatal ontogenesis, when the functional organ systems in the calves of the fifth generation develop and the species specificity for feeding evolve. In addition, this is a phase of physiologically intensive sexual development in the cattle at 8-9 months of age [19]. The experiment on using the Montbeliard bulls for the Simmental breeding stock to improve the modern Holstinized population of the Simental cattle was conducted. The new genotype offspring behavior under the effects of the intensive production technology was studied using the ethology approaches. The positive practice of the European countries, the countries in

North America, and China in order to improve the cattle of the modern dairy breeds with the Montbeliard bulls having the common origin with the Simmentals and the longer productive life [20, 21, 22] were taken into account.

The novelty of the survey is in the fact that the Montbeliard bull semen has been used in the Russian Holsteinized Simmental breeding stock characterized by the herd average milk yield of more than 7.0 thousand kg per cow. Ethology as the study of behavior is applied. The live weight and the milk yield in the produced offspring of different genotypes, reared under the effects of the intensive technologies, are analyzed.

The objectives of the survey for the ethological observations of the Simmental youngstock and cows of different genotypes are to assess the animal physiological status by the external manifestations, to compare the behavioral patterns according to the animal genotypes, to determine the time spent on feed-, motion- and production system-group-related behaviors. Therefore, the survey is focused on the factors influencing the Simmental animals within each genotype.

MATERIALS AND METHODS

The study of bihavior of the Simmental cattle of the new genotypes, involving the applied ethology, was carried out with the cows having the milk yield of more than 7.0 thousand kg per lactation over the period from 2013 to 2018 in the herds of the Central Federal District, Russian Federation. The animals were kept in the loose stall systems.

The animals were divided into two groups of six animals each; group 1: ¼ Simmental x ¾ Holstein; group 2: 1/8 Simmental x 3/8 Holstein x 1/82 Montbeliard. The groups involved the offspring produced from 2-3 bull sires. The difference between the milk yields of the offspring mothers comprised ¼ δ. The date of birth of the sampled animals varied within two weeks.

The observed feeding and elementery behaviors (EB) including sleeping patterns were registered according to the developed ethoprogram. The quantitative calculations in the absolute values and the relative percentage of the action-time ratios for all the fixed action patterns were performed describing the behavior. The observation time corresponded to the interval between the start and the end of the animal maintenance activity.

The motion activity index (MAI), the feeding activity index (FAI), and the production-system group dependence index (PSGDI) including the relative time spent by the group of animals for milking, manure removing, and the other techniques, excluding the access to feeds were calculated.

The experimental data processing was performed with the Micrsoft Office Excel 2007 software according to the standard methods.

RESULTS AND DISCUSSION

The most expressed behavioral responses in the animals of the analyzed genotypes are the feeding patterns. A feed intake is one of the major types of the vital activity, following by the maximum effort required from a specimen to be adequately satisfied.

By the time the calf is six months old, the digestive system typical to the mature ruminants is developed. Our surveys have proven that the developing animals eat the feeds 10-14 times a day. The maximum rate of feedlot visits is recorded for the Montbeliard bull heifers at 8-9 months of age, showing a significant superiority (Table 1). The data on the young-stock feed intake rates, obtained by the other researchers, generally show the similar variations [24, 25, 26]. The average duration of the feed intake for the first-group heifers at 5-6 months of age and 8-9 months of age comprised 20.8 minutes and 21.3 minutes, respectively; the variations were in the range of 3.5 minutes to 53 minutes. With respect to the Montbeliard blood heifers of group 2, the similar values comprised 17.5 minutes and 18.4 minutes, respectively, with the variations in the range of 2.8 minutes to 41.6 minutes. Therefore, both the average time and the limited time for a feed intake per visit in these heifers were shorter. The total feed intake time by the groups of heifers at 5-6 months of age was at the level of three hours, while it comprised four hours in the heifers at 8-9 months of

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age. It should be noted that the periods for ruminating in the Monbeliard blood heifers at 5-6 months of age and 8-9 months of age (group 2) were shorter by 36 minutes and 20 minutes, respectively. The published data report that the eating time for the developing animals generally varies from two to four hours a day [25].

The feed intake time for the first-calf heifers in group 1 and 2 at 5-6 months of age increased 1.6 and 1.3 times as much, respectively; the ruminating time increased 1.8 and 2.6 times as much, respectively. The feed intake rates in the first-calf heifers of both groups were at the same level and comprised 10.5 numbers. The eating time in the Montbeliard blood heifers compared to the first-group cows was shorter (- 62.3 minutes), while the ruminating time was longer (+21 minutes) with the preferable lying pattern of behavior (+ 44.5 minutes).

The surveys have reported that the variations in the rumination time are associated with the observed differences between the breeds in the feed intake patterns according to the animal age groups [24, 27, 28].

The feeding behavior took the major part of the active day time equal to the observation time (Fig. 1). Thus, the feeding activity indices (FAI) for the heifers at 5-6 months of age in group 1 (1/4 SIM x ¾ HST) and in group 2 (1/8 SIM x 3/8 HST x ½ MB) comprised 44.2% and 4.5%, respectively. The FAI of the feeding behavior of the six-month animals of both groups was at the same level and comprised 49.9% and 49.9%.

The feed activity index for cows unlike the eight-nine-month heifers mostly depended on the genotype. Thus, the index for the first-group cows and the second-group cows (with the Monbeliard blood) comprised 60.6% and 56.9%, respectively. The last-named cows spent 6.6% less time for the feed intake, while the time spent on ruminating was 2.7% longer, than that for the cows in the first group.

The difference in the feed intake was greater expressed in the cows, than that in the developing heifers, which was reported in the other researches [29]. Thus, the cows with the Montbeliard blood spent 6.5% less time for the feed intake, while the rumination took the time longer by 2.7%, than that in the cows with the high degree of consanguinity of the Holsteins (group 1). The Montbeliard bull heifers at 5-6 months of age and 8-9 months of age spent the ruminating time shorter by 4.6% and 2.1%, respectively (Fig. 1).

The daughters of the Montbeliard bulls at 5-6 months of age spent -0.8% shorter time for drinking water, while the time spent for it by the animals at 8-9 months of age was longer (+0.7%). The time percentage for water drinking was practically the same.

Table 1: Ethological studies of feed behavior of the heifers specified by different genotypes according to age distribution and the cows

Item	5-6 months		8-9 months		Cows, first lactation	
	¼ SIM x ¾ HST	1/8 SIM x 3/8 HST x ½ MB	¼ SIM x ¾ HST	1/8 SIM x 3/8 HST x ½ MB	¼ SIM x ¾ HST	1/8 SIM x 3/8 HST x ½ MB
Length of observation period	784	784	952	952	904	892
Drinking	16,5 ±2,3	22,7 ±10,1	16,3 ±3,1	23,0 ±6,7	3,2 ±0,9	4,2 ±1,4
Rate of feedlot visits, numbers	9,7 ±1,3	9,9 ±0,4	11,5* ±1,0	14,2 ±0,7	10,5 ±0,3	10,5 ±0,3
Feed intakes, total	192,5 ±13,0	186,1 ±16,5	231,3 ±11,3	247,5 ±21,2	302 ±27,6	239,7 ±23,9
Feed intake time per visit	21,3 ±3,0	18,4 ±1,4	20,8 ±1,9	17,5 ±1,5	34,8 ±2,6	34,8 ±2,6
Min feed intake time	**3,5** ±0,8	3,9 ±0,7	5,3 ±1,5	2,8 ±0,6	29,0 ±2,6	24,0 ±3,3
Max feed intake time	53,0 ±9,6	41,6 ±2,6	50,7 ±7,3	39,8 ±3,2	44,0 ±2,6	41,0 ±3,3
Ruminating, total	137,5	101,5	224,0	204	243,2	264,2

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time	±23,1	±13,9	±20,9	±35,6	±31,2	±30,5
Ruminating while standing	16,7 ±8,0	12,3 ±9,6	16,7 ±8,0	12,3 ±9,6	71,8 ±18,5	64,8 ±27,4
Ruminating while lying	118,1 ±24,6	89,3 ±15,2	198 ±22,9	184 ±33,9	154,8 ±35,2	199,3 ±44,2
Feed intake + rumination	330 ±20,7	288,5 ±12,2	459,0 ±20,1	452 ±41,2	545,2 ±24,2	503,2 ±11,1
Live weight, kg	161 ±0,30	175 ±0,38	231,0 ±4,99	240 ±9,30	557,5 ±4,8	567,3 ±4,8

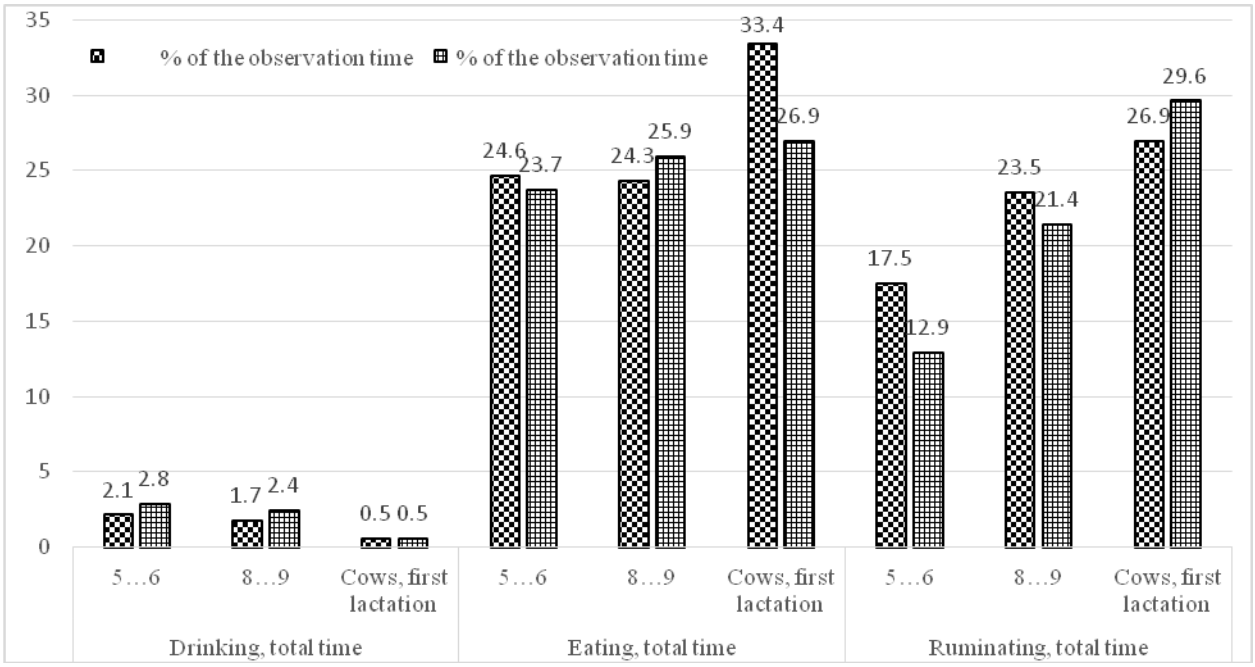

Fig 1 Feed behavior of the heifers specified by different genotypes according to age distribution (months) and the cows

The motion activity difference was more significant between the cows of two genotypes, rather than that between the heifers. The level of the motion acivity in the cows produced from the Montbeliard bulls was lower by 7%. In addition, the standing time spent by the Montbeliard bull cows (group 2) was 72.4 minutes shorter, than that in their peers of group 1.

The older the animals became, the longer they stood. Thus, the 8-9 month old heifers compared to the 5-6 month old heifers stood longer by 28.3% and 32.0%, respectively. The first-calf cows stood 36.5% and 15.9% longer, than that in the heifers in the prepubertal period (at 8-9 months of age) (Table 2).

The distinctiveness of the features of the motion behavior lay in the fact that the Monbeliard bull heifers in the period of the intensive sexual development, unlike the peers with a high degree of consanguinity of the Holsteins, mostly spent the time standing (+ 2.8%). Contrary to this, the cows spent 7.1% less time standing, since they spent 7.1% longer time lying, when compared to their peers with ¾ Holstein content (Fig. 2). With respect to the absolute time length, the cows spent the time lying twise as shorter as that in the heifers. Morover, the cow with the Montbeliard blood spent time lying for 60 minutes longer, than that in the cows of group 1. In addition, the similar dynamics of the lying time was reported in the reserches [30].

The animal sleep time reduced with age. The sleep time of the Montbeliard bull daughters at 5-6 months of age, compared to the first group peers, was longer by 39.4 minutes. However, it was shorter by 18 and 8.3 minutes in the 8-9 month old heifers and the first-calf heifers, respectively. In the period of the intensive sexual development (809 months), the sleep time in the heifers of groups 1 and 2 reduced by 23%

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and 57%, respectively, when compared to the animals of the younger age. Moreover, it decreased once more by 42.8% and 39.3%, respectively, in the first-calf heifers.

The motion activity index in the Montbeliard bull daughters compared to the peers having high levels of Holstein blood was more elevated only in the period of the sexual development (42.2% vs 39.5%).

Table 2: Ethological studies of motion behavior of the heifers according to age distribution and the cows

Item	5-6 months		8-9 months		Cows, first lactation	
	¼ SIM x ¾ HST	1/8 SIM x 3/8 HST x ½ MB	¼ SIM x ¾ HST	1/8 SIM x 3/8 HST x ½ MB	¼ SIM x ¾ HST	1/8 SIM x 3/8 HST x ½ MB
EB	330,4 ±13,9	335,7 ±23,5	376,0 ±11,9	402,0 ±23,1	308,2 ±23,7	304,2 ±15,3
Including walking	148,7 ±19,8	155,2 ±20,0	201,7 ±23,3	222,7 ±23,1	192,0 ±22,6	143,7 +6,7
Standing, total time	391,0 ±15,8	400,1 ±17,9	502,0 ±13,1	528,5 ±34,2	685,2 ±30,8	612,8 ±46,4
Lying, total time	393,4 ±15,5	383,7 ±17,9	450 ±13,1	423,5 ±34,2	219,2 ±36,1	279,3 ±41,1
Sleeping, total time	101,0 ±17,6	140,4 ±15,2	78,0 ±17,5	59,8 ±28,7	44,6 ±16,2	36,3 ±14,2

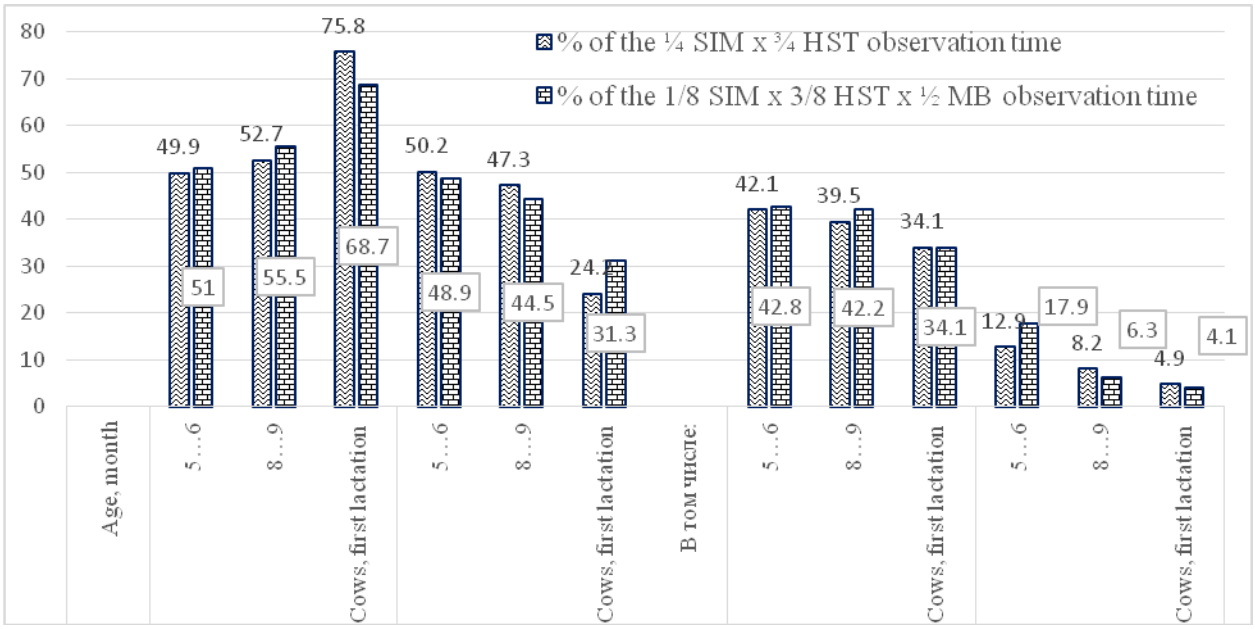

Fig 2: Ethological studies of movement patterns of behavior in the heifers according to age distribution and the cows (minutes)

The production-system group dependence index for the Montbeliard bull cows was practically two times higher (25.4%), than that in the peers with ¾ of Holstein blood (14.2%). The index value was generally affected by the time for keeping the cows in a holding yard before their milking. In addition, the cows produced from the Montbeliard bulls tend to behave quietly; the even-tempered animals express sociability and groming and allogrooming behavior. In the analyzed periods, the Montbeliard bull heifers excelled the peers with ¾ Holsten blood in the live weight by 9.0…14 kg.

The average daily milk yield in the cows of both groups at the 3-4 month of lactation comprised 25.1 kg and 25.6 kg, respectively.

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CONCLUSIONS

The researches have proven that the most expressive behavioral responses are the feeding patterns. Thus, the feeding activity indices (FAI) in the 5-6 month old heifers of genotype 1/4 SIM x ¾ HST and genotype 1/8 SIM x 3/8 HST x ½ MB comprised 44.2% and 4.5%, respectively. The FAI of the feeding behavior of the six-month old animals of both groups was at the same level and comprised 49.9% and 49.9%. The developing animals eat the feeds 10-14 times a day. The maximum reliable rate of feed intake was typical for the 8-9 month old heifers produced from the Montbeliard bulls; the feed intake time per a visit (17.5 minutes and 18.4 minutes) at 5-6 and 8-9 months of age was shorter by 3.3 minutes and 2.9 minutes, respectively. The total feed intake time by the groups of heifers at 5-6 months of age was at the level of three hours, while it comprised four hours in the heifers at 8-9 months of age. The ruminating periods for the Monbeliard blood heifers at 5-6 months of age and 8-9 months of age (group 2) were shorter by 36 minutes and 20 minutes, respectively.

The feed intake rates in the first-calf heifers of both groups were at the same level and comprised 10.5 numbers. The eating time in the Montbeliard blood heifers compared to the first-group cows was shorter (- 62.3 minutes), while the ruminating time was longer (+21 minutes).

The feed activity index for cows was more expressed by the genotypes, unlike the eight-nine-month heifers. Thus, the index for the first-group cows and the second-group cows (with the Monbeliard blood) comprised 60.6% and 56.9%, respectively. The last-named cows spent 6.6% less time for the feed intake, while the time spent on ruminating was 2.7% longer, than that for the cows of group 1.

The difference in the feed intake was more expressed in the cows, than that in the developing heifers, which was reported in the other researches [29]. Thus, the cows with the Montbeliard blood spent 6.5% less time for the feed intake, while the rumination took 2.7% longer time, than that in the cows with the high degree of consanguinity of the Holsteins (group 1). The Montbeliard bull heifers at 5-6 months of age and 8-9 months of age spent 4.6% and 2.1% less ruminating time, respectively.

The time percentage for water drinking was practically the same.

With respect to the motion activity, the greater difference between the cows of two genotypes, rather than between the heifers was recorded. The distinctiveness of the features lay in the fact that the Monbeliard bull heifers in the period of the intensive sexual development, unlike the peers with a high degree of consanguinity of the Holsteins, mostly spent the time standing (+ 2.8%). Contrary to this, the cows spent 7.1% less time standing, since they spent 7.1% longere time lying, when compared to their peers with ¾ Holstein content**.**

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The motion activity index in the Montbeliard bull daughters compared to the peers having high levels of Holstein blood was higher only in the period of the sexual development (42.2% vs 39.5%).

The production-system group dependence index for the Montbeliard bull cows was practically two times higher (25.4%), than that in the peers with ¾ of Holstein blood (14.2%). The index value was generally affected by the time for keeping the cows in a holding yard before their milking. In addition, the cows produced from the Montbeliard bulls tend to behave quietly; the even-tempered animals usually express sociability and groming and allogrooming behavior.

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The average daily milk yield in the cows of both groups at the 3-4 month of lactation comprised 25.1 kg and 25.6 kg, respectively.

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