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THE INFLUENCE OF CHANGING CONDITIONS FOR KEEPING AND COWS' MILKING ON THEIR BEHAVIOR, PRODUCTIVITY AND CONDITION

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Abstract
The aim of this work was to study the behavior, productivity and conditions of second lactation *Bos taurus* during the period of adaptation to new keeping and milking conditions. Thirty-four cows of the local black-and-white breed of the second lactation (24–47 days after calving) were transferred from a brick barn for 100 heads with tie-stall keeping in a newly low cost housing facility for 400 heads with free-stall keeping. Milking equipment also changed: before the changing conditions of keeping, cows were milked in the milk duct at UDM-100, and after changing the conditions in the milking parlor at Carousel, 32 cows were milked at the same time. We divided the first 30 days in the new conditions of keeping and milking into VI periods. The duration of the main behavioral reactions: lying down, drinking, and eating food in the first days after changing the conditions of keeping and milking decreased significantly – by 181; 13 and 89 min, respectively. Behavioral responses at the end of the adaptation period (30 days) was lower than on the last day before changing housing and milking conditions. During the first 5 days after the change of housing and milking conditions, the average productivity of cows decreased by 1.39 kg (or 6.01%), content of milk fat, protein and lactose by 0.03; 0.02 and 0.04%, respectively compared to the last day before the transfer of animals. As for the fat content, the level of the indicator of the last day before the cows transfer was reached in the IV period; protein and lactose in the III period (11–15 days).
Key words: dairy cows, tie-stall, free-stall, milking parlour, adaptation, behavior and productivity.

Introduction

The body of ruminants has the ability to regulate physiological processes independently, maintaining the internal environment within constant limits. The use of dairy cattle in an unusual environment (change of climatic zone or method of keeping) largely depends on the level of compliance of new housing conditions with hereditary traits of the organism and the level of adaptation to conditions (technologies) of keeping, feeding and milking (Webster *et al.*, 2008).

The efficiency of production activities of industrial dairy complexes largely depends on the extent to which the current technology meets the biological needs of animals. The adaptive capabilities of the body of dairy cattle are influenced by a set of environmental factors, which significantly affect the productivity of animals (Krawczel & Grant, 2009). Along with the level of feeding and genetic properties, the technology of keeping and milking of *Bos taurus* is important (Borshch, Ruban, & Borshch, 2021).

High productivity, reproductive traits, and feed efficiency are important indicators of successful adaptation of dairy cattle to changes in the environment and housing technology, milking equipment and level of feeding (O'Driscoll, Hanlon, & Boyle, 2008). The parameters of daily behavior of animals are also important, because during the first periods after changing the conditions of keeping and milking cows have a significant stress load, which affects productivity, milk quality and duration of economic use of animals. It is advisable to assess the adaptive traits of dairy cattle after a certain period (20–30 days), during which animals either acclimate to the new conditions of keeping and milking, restoring the former productive traits, or do not restore their productive potential (Cook, 2007; Pavlenko *et al*., 2018). Behavior is considered to be the most important indicator of the detection of all abnormalities in animal health and productivity. It finds expression in all elements of production technology, forming in combination with climatic, mechanical and organizational factors, a complex system (Ruban *et al.*, 2020; Sitkowska *et al*., 2015).

One of the current trends in the development of dairy farming is the use of intensive technologies of milk production. At the same time, the requirements for the dairy herd as the main means of production are growing. Cows suitable for use in a high-tech complex must have high productivity, sound constitution and high reproductive qualities (Borshch *et al*., 2020). Changes in housing conditions are accompanied by deviations from the established method, rhythm and schedule of existence of animals and loss of productivity, condition and problems with limbs (lameness). This is especially noticeable when changing not only the conditions of keeping, but also milking, because during increasing the milk yield the neuroreceptor system of cows begins to experience regular periodic irritation by the vacuum of the milking machine. These actions negatively affect both the productivity and the health of the cows' udder.

The aim of this work was to study the behavior, productivity and conditions of second lactation cows during the period of adaptation to new keeping and milking conditions.

Materials and Methods

The research was conducted on a commercial farm located (49°48′45"N30°18′56E) in Kyiv region (Ukraine). Thirty-four cows of the local black-and-white breed of the second lactation (24–47 days after calving) were transferred from a brick barn for 100 heads (Length × Width × Height: 76×12×6 m) with tie-stall keeping in a newly low cost housing facility for 400 heads (Length × Width × Height: 138×36×9.54 m) with free-stall keeping. All animals were not pregnant. Milking equipment also changed: before the changing conditions of keeping, cows were milked in the milk duct at UDM-100, and after changing the conditions in the milking parlor at Carousel, 32 cows were milked at the same time (GEA Farm Technologies, Germany). Daily milking frequency before and after the change of keeping conditions was three times. The change in housing conditions took place during May–June 2020; the average daily temperature was, according to West, (2003) thermoneutral for dairy cows (+15.8 °C). We divided the first 30 days under the new conditions of keeping and milking into six periods: the I period – 1–5 days; the II period – 6–10 days; the III period – 11–15 days; the IV period – 16–20 days; the V period – 21–25 days and the VI period – 26–30 days. During the study periods, the mean values of cows' behavior and behavioral indices, milk productivity and composition, fatness assessment, and assessment of walking were determined. During 5; 10; 15; 20; 25 and 30 days, direct visual observations of animals were performed, during which cases (and number of animals) of contact of cows with boxes (lying, standing, standing with forelimbs) were recorded.

Cow's behavior was determined by using internal surveillance cameras (8 Hikvision cameras Full HD). Filming in all barns takes place around the clock. Placing cameras in the barns allows you to record a recreation area, feeding passage and drinking bowls area and cows moving. Every 10 min, 32 cows involved in the experiment were observed: the number of cows, which during the observation consumed food, rested by standing or lying, moved and drank water were recorded.

Optimal duration of cows behavioral reactions was determined according to Cook, 2020. The effect of free-stall housing on stall comfort, welfare, and natural behavior of cows is used by practical indices including cow comfort index (CCI): number of cows lying in stalls per number of cows in contact with stalls: (Nelson, 1996); stall standing index (SSI): number of cows standing in stalls per number of cows in contact with stalls (Cook, Bennett, & Nordlund, 2005); stall perching index (SPI): number of cows standing with 2 front feet in the stall and the rear feet in the alley per number of cows in contact with stalls (Tucker, Weary, & Fraser, 2005), and stall use index (SUI): number of cows lying in stalls per number of cows not actively feeding (Overton *et al*., 2002).

Daily milk fat, protein, and lactose concentrations were determined on three consecutive (morning, midday and evening) milk samples (Milkotester Lactomat Rapid S, Bulgaria).

Fat-corrected milk (3.5% FCM) was calculated using the equation (NRC, 2001):

FCM = [0.432 × milk yield (kg day^{-1}) + 16.23 × milk fat yield (kg day^{-1})] (1)

Energy-corrected milk (ECM) yield was calculated as by Tyrrell & Reid, (1965):

ECM = [0.327 × milk yield (kg day^{-1}) + 12.95 × milk fat yield (kg day^{-1}) + 7.2 × milk protein yield (kg day^{-1})] (2)

The study locomotion scoring system was compared with criteria of Sprecher, Hosteler, & Kaneene, (1997), where 1 point – normal and 5 point – severely lame. Body condition score was determined according to 5-point scale (Edmondson *et al*., 1989).

The obtained data were statistically processed using STATISTICA (Version 11.0, 2012) software. The Student's *t*-test was used to estimate the statistical significance of the obtained values. Data were considered significant at $p<0.05$, $p<0.01$, $p<0.001$.

Results and Discussion

Research results have shown that changes in housing and milking conditions have become a significant stressor for cows. The duration of the main behavioral reactions: lying down, drinking, and eating food in the first days after changing the conditions of keeping and milking decreased significantly – by 181; 13 and 89 min, respectively (Table 1). At the same time, the duration of standing on the contrary increased by 48 min. During the adaptation period (30 days) to the new conditions of keeping and milking, the duration of lying cows increased from the second period (6–10 days) of observations. The difference in the duration of lying cows between periods I and VI was 114 min day^{-1}. The duration of feed consumption increased from the second period (by 9 min), and the largest increase occurred during the third period – by 18 min compared to the second period. In general, the duration of feed consumption during the observation period increased by 71 min. The most significant increase in the duration of lying down occurred during the third period: 73 min. The value of standing duration, on the contrary, decreased with each subsequent period. It was especially significant during the second period (48 min compared to the first period). In total, the difference between periods I and VI was 79 min. The duration of walking also decreased during the study period (by 45 min compared to the I period). The duration of watering during the adaptation period increased by 10 min compared to the I period.

Table 1

Duration of behavioral reactions of cows during the adaptation period, min per day

Behavioral reactions	Last day before milking parlor and housing system change	Periods, their start and end days					
		I 1–5	II 6–10	III 11–15	IV 16–20	V 21–25	VI 26–30
Lying	809±19.4	628± 11.1	654± 10.4	701± 12.7***	717± 14.9***	738± 14.2***	742± 15.9***
Feeding	296±15.8	207± 8.4	216± 9.4	234± 8.2*	242± 11.1*	257± 12.8**	263± 14.5**
Moving	–	93± 2.8	74± 2.3***	68± 2.1***	62± 2.0***	54± 1.8***	48± 1.2***
Standing	188±5.1	236± 8.3	188± 6.7***	173± 6.2***	167± 5.9***	165± 5.8***	157± 5.3***
Water drinking	47±0.8	34± 0.4	34± 0.3***	37± 0.6***	39± 0.7***	41± 0.9***	44± 1.1***

Note: *p<0.05; **p<0.01; ***p<0.0.001 as compared with I period.

The lack of restraint in the movement with free-stall keeping affected the change in the ratio of daily behavioral responses. Animals had to cross-distances for eating, drinking, and milking compared to tie-stall housing, so the duration of behavioral responses at the end of the adaptation period (30 days) was lower than on the last day before changing housing and milking conditions. Behavior and productivity of cows after changes in housing conditions were mostly studied when transferring animals from stall keeping indoors (winter) to grazing (summer) (Schnier, Hielm, & Saloniemi, 2003; Zähner *et al*., 2004). The results of our research coincide with the data obtained by Slovak scientists, who indicated a decrease in the duration of lying in Holstein breed cows after transferring them from tie-stall keeping to free-stall keeping (Broucek *et al*., 2017).

During the first 5 days after the change of housing and milking conditions, the average productivity of cows decreased by 1.39 kg day^{-1} (or 6.01%) compared to the last day before the transfer of animals to free-stall housing (Table 2). At the same time, the indicators of the content of fat, protein and lactose in milk decreased: by 0.03; 0.02 and 0.04%, respectively, as well as the value of the energy-corrected milk by 1.57 kg day^{-1} (or 6.51%) and fat-corrected milk by 1.55 kg day^{-1} (or 6.44%). The productivity of cows during the 30 days of adaptation gradually increased (by 0.13–0.65 kg) with each subsequent period and in the V period reached the level of the last day before transfer to new housing conditions. As for the fat content, its value increased by 0.01% during the II period and was at a stable level until the end of the III period (11–15 days), and in the IV period reached the level of the last day before the transfer. The total difference in fat content in milk at the end of the study was 0.04% (compared with I period). The content of milk protein during the period of monthly observations increased by 0.05% achieving the level of the last day before the transfer took place in the III period (11–15 days). The largest increase in protein content was observed in the IV period (16–20 days) – by 0.04% (compared to the I period). During the research period, the content of lactose increased most among the components of milk: by 0.06% (in the VI period compared to the I period), and reached the level of the last day before the transfer took place in the III period. In accordance with the increase in the main components of milk (fat, protein, lactose) during the study period, the values of the energy-corrected milk increased by 1.87 kg day^{-1} (in VI period) and fat-corrected milk per 1.79 kg day^{-1}, respectively. Our data are partially in line with the data from a team of scientists at the University of Wisconsin-Madison (USA) who indicate that after changes in housing conditions, which included moving cows to new premises with free-stall keeping, productivity recovered faster than when animals were housed into renovated premises (Bewley *et al*., 2001). Broucek *et al*. (2013) reported about decrease in productivity in cows (by 23.28%) on the first day after changing housing and milking conditions. The results of these studies coincide with our results.

One of the fundamental indicators of the state of the dairy cow's bodies in the period of changing housing and milking conditions, as well as in the period of maximum productivity (1–3 months of lactation) is the body condition and locomotion scores (Wang *et al*., 2016). It was found that body condition in cows during the adaptation period gradually decreased starting from the II and ending with the VI period. In general, body condition during the study period decreased by 0.44 points (Table 3). Regarding the cows' locomotion score, its values during the

Table 2

Milk yield and composition during adaptation period

Indicators	Last day before milking parlor and housing system change	Periods, their start and end days					
		I 1–5	II 6–10	III 11–15	IV 16–20	V 21–25	VI 26–30
Milk yield, kg day^{-1}	23.16± 0.48	21.77± 0.33	22.08± 0.40	22.38± 0.44	23.03± 0.48*	23.21± 0.50*	23.34± 0.51*
Fat, %	3.75± 0.02	3.72± 0.01	3.73± 0.01	3.73± 0.01	3.75± 0.02	3.75± 0.02	3.76± 0.02
Protein, %	3.18± 0.03	3.16± 0.02	3.16± 0.02	3,19± 0,03	3.20± 0.03	3.20± 0.03	3.21± 0.03
Lactose, %	4.10± 0.02	4.06± 0.02	4.07± 0.02	4.10± 0.02	4.10± 0.02	4.11± 0.03	4.12± 0.02*
FCM, kg day^{-1}	24.10± 0.55	22.53± 0.26	22.89± 0.28	23.20± 0.31	23.96± 0.39**	24.05± 0.40**	24.32± 0.40**
ECM, kg day^{-1}	24.06± 0.27	22.51± 0.21	22.89± 0.23	23.26± 0.29*	24.01± 0.32***	24.20± 0.30***	24.38± 0.33***

Note: *p<0.05; **p<0.01; ***p<0.001 as compared with I period.

Table 3

Body condition score and locomotion score change during adaptation period

Indicators	Last day before milking parlor and housing system change	Periods, their start and end days					
		I 1–5	II 6–10	III 11–15	IV 16–20	V 21–25	VI 26–30
Body condition score	3.21±0.35	3.21± 0.35	3.09± 0.16	3.03± 0.19	2.92± 0.22	2.86± 0.15	2.77± 0.19
Locomotion score	-	1.33± 0.06	1.33± 0.06	1.33± 0.06	1.68± 0.12*	1.68± 0.12*	1.68± 0.12*

Note: *p<0.05 as compared with I period

Table 4

Values of indices that characterize cow comfort during adaptation period, %

Comfort indices	Periods, their start and end days					
	I 1–5	II 6–10	III 11–15	IV 16–20	V 21–25	VI 26–30
CCI	70.24± 1.16	73.82± 2.84	78.33± 2.63**	86.64± 4.19***	88.26± 4.81***	90.54± 5.06***
SSI	18.68± 0.29	16.53± 0.24***	15.45± 0.23***	9.12± 0.12***	7.53± 0.10***	6.78± 0.08***
SPI	11.08± 0.17	9.65± 0.13***	6.22± 0.08***	4.24± 0.07***	4.21± 0.07***	2.68± 0.05***
SUI	54.19± 2.08	59.07± 2.77	66.38± 3.19**	71.66± 3.41***	78.43± 3.96***	82.26± 4.20***

Note: *p<0.05; **p<0.01; ***p<0.001 as compared with I period.
CCI – cow comfort index; SSI – stall standing index; SPI – stall perching index; SUI – stall use index.

I–III periods were equal: 1.33 points with a slight increase in IV to 1.68 points. These values of locomotion score are acceptable for dairy cattle, which indicates good adaptation of animals to changes in housing technology.

The data obtained by us coincide with the data of various groups of scientists who also indicate a decrease in the body condition score in cows in the first months after calving (Rafia *et al*., 2012; Roche *et al*., 2013; 2009).

To more fully study of the influence of changes in housing conditions and milking on the behavior of cows, we studied the values of four comfort indices for boxing, which depend on the indicators of daily behavior. The values of cow comfort index (CCI) and stall use index (SUI), which depend on the daily duration of rest lying down, increased with each subsequent period and in the VI period increased by 20.30 and 28.07%, respectively (Table 4). At the same time, the stall standing index decreased by 11.90% during the 30-day adaptation period, and the stall perching index decreased by 8.40%.

Conclusions

Changes in housing and milking conditions at the beginning of the adaptation period during 14–21 days became a significant stress factor for dairy lactating cows, which led to reduced productivity, worsening of milk quality and reduced basic behavioral responses (lying down, feed consumption, watering, and led to increase of motor activity). During the 30 days of adaptation, the productivity of cows, milk quality exceeded the level reached before the transition to new conditions, and behavioral responses were slightly lower, but met the recommended values for dairy cows.

The results of the research can be used in the reconstruction and modernization of existing dairy farms with tie-stall keeping and their transfer to free-stall keeping and milking in milking parlors, as well at the construction of new farms using cows which were kept under other technological conditions.

For reduction of the adaptation period and decreasing the negative impact of changes in housing and milking conditions on the productivity and comfort of second lactation cows, it is necessary to transfer to other housing conditions no later than one month after calving. It is desirable to change the housing conditions for lactating cows during the thermo-neutral temperature period (up to +25 °C). At the same time, it is necessary to ensure full feeding, comfort of housing conditions and to follow the rules of automated milking during the adaptation period under the new housing conditions.

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