

Молочная продуктивность коров и качество молока, произведенного на пастбищных угодьях различной высотной зональности

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Цель исследования – изучение молочной продуктивности крупного рогатого скота и качества молока в зависимости от травостоя пастбищных угодий в летний период содержания. Исследование проводили на пастбищах различной высотной зональности, входящих в территорию Центрального Предкавказья. Объектом изучения являлись коровы бурой швицкой породы. Были сформированы две группы полновозрастных коров по 20 гол. в каждой: 1-я опытная – высота расположения пастбищ 1100 м н. у. м., 2-я опытная – высота 2400 м н. у. м. В обеих группах наибольшие суточные удои зарегистрированы в середине периода пастбищного содержания, когда животные паслись на более питательном разнотравье. При этом коровы 2-й группы в отличие от представительниц 1-й группы в анализируемый период отличались наибольшей молочностью – 19,4 и 17,7 кг молока соответственно ($p > 0,95$). Межгрупповые различия к концу исследования составили 2,2 кг в пользу особей, содержавшихся на высоте 2400 м н. у. м. ($p > 0,99$). К середине пастбищного периода преимущество коров из более высокогорной зоны по концентрации в молоке жира и белка составило 0,07 ($p > 0,95$) и 0,05% ($p > 0,95$) соответственно, что, вероятно, связано с более питательным составом трав на пастбищах, расположенных в альпийском и субальпийском поясе. Качественные показатели молока коров обеих групп изменялись в соответствии с периодом содержания на пастбище – к середине увеличивались и постепенно снижались к концу исследования, что обусловлено снижением питательности поедаемой животными растительности. Использование отгонно-горной системы содержания молочного скота в пастбищный период в условиях Центрального Предкавказья обеспечивает увеличение продуктивности, улучшение качественных характеристик молочного сырья и его соответствие требованиям экологической безопасности. Горные территории с естественными кормовыми угодьями являются значительным ресурсом повышения эффективности скотоводства, обеспечивающим производство высококачественной продукции с наименьшими трудовыми и материальными затратами.

Ключевые слова: корова, молоко, пастбище, высотная зональность, химический состав, тяжелые металлы

Dairy productivity of cows and quality of milk produced on the pastures of different altitudinal zonality

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The purpose of the research is to study the milk productivity of cattle and milk quality depending on the grass of pasture lands in the summer period of rearing. The study was conducted on the pastures of different altitudinal zonality within the territory of the Central Pre-Caucasian region. The object of study was the cows of the Brown Swiss breed. Two groups of full-aged cows with 20 cows in each group were formed: the 1st experimental group – pasture location altitude 1100 m above sea level, the 2nd experimental group – altitude 2400 m above sea level. In both groups, the highest daily milk yields were recorded in the middle of the grazing period, when animals grazed on more nutritious grasses. The cows of the 2nd group in contrast to the representatives of the 1st group in the analyzed period were distinguished by the highest milk yield – 19.4 and 17.7 kg of milk, respectively ($p > 0.95$). Intergroup differences by the end of the study were 2.2 kg in favor of the individuals maintained at 2400 m above sea level ($p > 0.99$). By the middle of the grazing period, the advantage of cows from the higher altitude zone in milk fat and protein concentration was 0.07 ($p > 0.95$) and 0.05% ($p > 0.95$), respectively, which is probably due to the more nutritious composition of grasses on the pastures located in the alpine and subalpine belt. Qualitative indicators of milk of the cows of both groups changed in accordance with the period of keeping on pasture – by the middle increased and gradually decreased by the end of the study, which is due to a decrease in the nutritional content of vegetation eaten by the animals. The use of free range-mountain system of keeping dairy cattle in the pasture period in the conditions of the Central Pre-Caucasian region provides an increase in productivity, improvement of qualitative characteristics of dairy raw materials and its compliance with the requirements of environmental safety. Mountainous areas with natural forage lands are a significant resource for increasing the efficiency of cattle breeding, ensuring the production of high-quality products with the lowest labor and material costs.

Keywords: cow, milk, pasture, altitudinal zoning, chemical composition, heavy metals

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Conflict of interest

The authors declare no conflict of interest.

INTRODUCTION

The results of numerous studies by domestic and foreign scientists [1-5] testify to the beneficial effect of cattle grazing, which is quite widespread in many countries of the world on productivity, animal health and profitability of the industry. At the same time, with a significant increase in the number of cattle raised on pastures and their unregulated grazing, there is a decrease in the productivity of both farm animals and grass stands [6].

In the process of analyzing milk productivity of Holstein and Ayrshire cows it was established that when cattle are kept in extreme agro-climatic conditions, when grazing on pastures located in forb-fescue-feather grass steppes, higher milk yields are observed in summer period (especially in July), and higher quality milk indicators in winter months [7].

Due to optimization of the technology of stage-by-stage preparation of cows for transition from stall to pasture keeping which consists in calving in February – March, it was possible to

increase milk yields by 11% on average when using feed tables and by 8.5% when grazing on pastures within the framework of the stall-pasture keeping system in comparison with their peers under year-round stall keeping [8].

In the pasture period of keeping behavioral acts and productivity of cows at comfortable ambient temperature noticeably improve, in cool weather they are within the physiological norm, and when the air temperature rises to 32 °C they change significantly (shade seeking, consumption of more water, decrease in daily milk yield by 12%) [9].

In the milk of cows lactating indoors and on combined diets, in contrast to their counterparts consuming perennial ryegrass and alternating these forages, there was a predominant amount of dry matter, including lactose and protein [10]. Increasing the diversity of plant species in the pasture is suggested as one of the ways to increase the milk productivity of cows. For example, as a result of grazing on mixed grass as opposed to keeping on ryegrass grasses, milk yield increased by 1.1 kg per day, and the amount of dry skim milk residue by 0.08 kg¹.

Dairy cattle breeding on most continents of the world has shifted to high-yield cow breeding, which is primarily due to the use of combined high-nutrient rations fed indoors all year round. However, in some countries (New Zealand, Ireland, etc.), dairy production is oriented more towards pasture farming with maximum milk yield per unit of pasture area, resulting in significantly lower productivity than that of cows bred in North America and Europe².

In some regions of Russia, dairy cattle breeding with the use of the free range-mountain system of keeping as one of the ways of milk production with the lowest costs per unit of production is still preserved³ [11, 12].

Differences in the composition of grass in different areas of dairy cattle habitat prompted us to conduct a study to establish the productive and qualitative indicators of milk, determining the relevance of this problem in pasture cattle breeding.

The purpose of the research is to study the level of milk productivity of cows and milk quality depending on the nature of grass on pasture lands in the summer period of keeping.

Objectives:

- 1) study of herbage nutrient content at different heights;
- 2) determination of daily milk yield and chemical composition of milk;
- 3) analysis of heavy metal content in milk.

MATERIAL AND METHODS

The study was conducted on the pastures of different altitudinal zonality on the territory of the Central Pre-Caucasian region. The object of the study were cows of the Brown Swiss breed.

In the course of the experiment, two groups of full-aged cows (20 cows in each group) were formed taking into account the location of pastures: 1st experimental group – height of the plot of land location 1100 m above sea level, 2nd experimental group – height of 2400 m above sea level. The duration of the grazing period was 155 days. The nutrient content of the grass was judged according to the materials of agrochemical services located in the zone of the Central Pre-Caucasian region.

Milk productivity of cows (daily milk yield, fat and protein content in milk) in both groups was determined at the beginning, middle and end of the pasture period. In addition, studies were conducted to determine the presence of lead, cadmium, mercury and arsenic in milk by inductively coupled plasma mass spectrometry methods.

¹Roca-Fernández A.I., Peyraud J.L., Delaby L., Delagarde R. Pasture intake and milk production of dairy cows rotationally grazing on multi-species swards // *Animal*, 2016, N 10 (9), pp. 1448–1456.

²Knaus W. Perspectives on pasture versus indoor feeding of dairy cows // *Journal of the science of food and agriculture*, 2016, N 96 (1), pp. 9–17.

³Ulimbashev M.B. Resistance, hematologic indices and productive features of cows of the Brown Swiss breed at the distant-mountain keeping // *Agricultural Biology*, 2007, vol. 42, N 6, pp. 97–100.

The obtained individual values of productive indices of the experimental stock were subjected to biometric processing with establishment of reliability of intergroup differences by the Student's criterion.

RESULTS AND DISCUSSION

The nutritive value of pasture grass at different elevations and during different grazing periods is presented in Table 1.

Regardless of the altitude, the highest dry matter content of pasture grass was observed in the last days of grazing. Of all the analyzed nutrients, a decrease in protein and fat concentration was observed, especially from the middle to the end of grazing. The amount of protein in dry matter of mixed grasses at 2400 m altitude was slightly higher than on the pastures located at 1100 m altitude. At the same time, fiber concentration in grass dry matter increased during the grazing period, with the greatest increase at 1100 m elevation. The amount of nitrogen-free extractive substances differed slightly depending on both the time of sampling and the place of grass growth.

Indicators of milk productivity of experimental stock in different periods of grazing and at different altitudes are presented in Table 2.

In both groups, the highest daily milk yields were registered in the middle of the grazing period, when cows grazed on more nutritious grass. At the same time, animals kept at high elevation, in contrast to their counterparts kept at mid-elevation, had the highest milk production during the analyzed period: the daily milk yields of these groups were 19.4 and 17.7 kg, respectively (1.7 kg higher; $p > 0.95$). Intergroup differences by the end of the study amounted to 2.2 kg in favor of the individuals kept at an altitude of 2400 m altitude ($p > 0.99$).

At the beginning of the pasture period there were no intergroup differences in milk fat and protein concentration. Later on (by the middle of the grazing period), the advantage of cows from the higher altitude zone was 0.07 ($p > 0.95$) and 0.05% ($p > 0.95$), respectively, which is probably due to the higher nutrient content of the grass

Табл. 1. Концентрация основных питательных веществ в пастбищной траве в разные периоды содержания, %

Table 1. Concentration of main nutrients in pasture grass during different periods of cattle keeping, %

Indicator	Grazing period		
	beginning	middle	end
Elevation 1100 m altitude.			
Dry matter, total	13,3	20,2	26,1
Including:			
protein	26,2	23,8	13,0
fiber	17,6	19,7	32,0
fat	6,8	6,3	3,9
nitrogen-free extractive substances	42,7	41,0	44,6
ash	6,7	9,2	6,5
Elevation 2,400 m altitude			
Dry matter, total	16,5	24,0	25,8
Including:			
protein	27,0	25,0	15,2
fiber	17,0	19,0	27,2
fat	6,6	6,3	4,8
nitrogen-free extractive substances	42,4	41,5	44,8
ash	7,0	8,2	8,0

of the alpine and subalpine pastures. Milk quality parameters of cows of both groups changed in accordance with the period of keeping on pasture: in the middle they increased, and then gradually decreased by the end of the study, which is associated with a decrease in the nutrient content of vegetation.

According to the results of milk analysis for the content of a number of chemical elements, low concentration of heavy metals in raw milk obtained from cows of both groups was noted (see Table 3).

At the beginning of the study the presence of lead was recorded in milk samples, which, apparently, is explained by the fact that this substance was in the organism of the cows before their transfer to pasture keeping, later the level

Табл. 2. Молочная продуктивность коров на разных высотах и в связи с периодом пастбищного содержания ($X \pm m_x$)

Table 2. Milk productivity of cows at different altitudes and in connection with the period of grazing ($X \pm m_x$)

Indicator	Grazing period		
	beginning (10th day)	end (70th day)	end (145th day)
<i>Elevation 1100 m altitude</i>			
Daily milk yield, kg	14,3 $\pm$ 0,36	17,7 $\pm$ 0,50	15,6 $\pm$ 0,43
Fat content, %	3,92 $\pm$ 0,02	4,03 $\pm$ 0,02	3,94 $\pm$ 0,02
Protein content, %	3,18 $\pm$ 0,01	3,26 $\pm$ 0,01	3,20 $\pm$ 0,01
<i>Elevation 2,400 m altitude</i>			
Daily milk yield, kg	15,0 $\pm$ 0,41	19,4 $\pm$ 0,62	17,8 $\pm$ 0,51
Fat content, %	3,93 $\pm$ 0,02	4,11 $\pm$ 0,03	4,07 $\pm$ 0,03
Protein content, %	3,19 $\pm$ 0,01	3,31 $\pm$ 0,02	3,27 $\pm$ 0,02

of lead significantly decreased, reaching a trace amount by the end of the technological cycle. A similar pattern was observed for arsenic.

Mercury concentration in the milk of cows kept at different altitudes has a general tendency – reduction of indicators from the beginning to the end of the analyzed period, which indicates the environmental safety of dairy raw materials produced in the conditions of mountainous areas.

It is necessary to note the positive influence of cows keeping in higher altitude zone on cadmium concentration in milk. Thus, in the milk of animals of the 1st experimental group a higher concentration of cadmium was recorded in comparison with the 2nd group, although it did not exceed the normative permissible level.

CONCLUSION

Thus, according to the results of the study, it was established that the use of free range-mountain system of keeping dairy cattle in the pasture period in the conditions of the Central Pre-Cau-

casian region provides an increase in cow productivity, improvement of quality characteristics of dairy raw materials and its compliance with environmental safety requirements. Mountain territories with natural fodder lands are a significant resource for increasing the efficiency of the industry, ensuring the production of high-quality products with the lowest labor and material costs.

The indicators of daily milk yield and quality characteristics of milk increased in the middle of the pasture period of keeping and naturally decreased by the end of the period, which is associated with a decrease in the nutrient content of the grass of mountain fodder lands. At 1100 m altitude the daily milk yield at the beginning of the grazing period was lower than in the middle of the period by 3.4 kg, at 2400 m altitude by 4.4 kg. The analysis of milk nutrition also had a dependence on the time of sampling, and the patterns obtained from the level of milk yield were also characteristic of the qualitative indicators of milk.

Табл. 3. Содержание тяжелых металлов в молоке, мг/кг ($X \pm m_x$)

Table 3. Content of heavy metals in milk, mg/kg ($X \pm m_x$)

Element	Grazing period		
	beginning	middle	end
Elevation 1100 m altitude			
Lead: actual	0,002	0,001	Trace amount
MAC		0,1	
Arsenicum: actual	0,002	0,001	Trace amount
MAC		0,05	
Mercury: actual	0,00027	0,00021	0,00012
MAC		0,005	
Cadmium: actual	0,0002	0,0001	0,0001
MAC		0,03	
Elevation 2,400 m altitude			
Lead: actual	0,001	Trace amount	Trace amount
MAC		0,1	
Arsenicum: actual	0,002	Trace amount	Trace amount
MAC		0,05	
Mercury: actual	0,00031	0,00018	0,00009
MAC		0,005	
Cadmium: actual	0,0002	Trace amount	Trace amount
MAC		0,03	

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