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Quantitative and qualitative responses of dairy cattle herds' production to proper feeding

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Abstract: The primary objectives include the development of the agro-industrial complex of the Republic of Moldova and ensuring the population has access to quality products. The assessment of qualitative and quantitative indicators of milk production and processing in the country, reflects the dynamics of the dairy industry's development and highlights the main issues that need solutions; hence, research on this matter remains relevant.
The aim of this study was to analyze both the quantitative and qualitative indicators of milk production, at the educational dairy farm of the Technical University in Moldova. Additionally, a review of research on the development of recipes based on feedstock and an examination of factors influencing the quality of dairy products were conducted. It was concluded that overall, the quality of milk at the educational dairy farm, in terms of fat and density content, and organoleptic properties, is good.

Keywords: cows; milk production; fat; nutritional requements; forages

INTRODUCTION

It is acknowledged that climate change represents a priority challenge facing humanity in the 21st century, which is no longer just a concern for the near future (Oprunescu, A., Prohnițchi, V., 2009). Climate change is expected to have an increased impact on agriculture, particularly on the forage base in the livestock sector. Given Moldova's transitional status and its less developed nature, rational feeding is one of the most important pillars affecting the productive capacity of dairy cows. The life and production of animals involve a continuous and uninterrupted exchange of substances between the organism and the environment.

Nutrition is one of the most important factors in ensuring optimal production parameters and requires both quantitative assurance and the optimal proportion of nutrients and water (Razumoskii, M., 2012). The share of feed costs represents over 60% of the costs of animal products. Proper feeding of a cow has a significant influence on its productivity. High milk yields and feed savings can only be achieved when all necessary nutrients are supplied to the cows through rationalization. A feed ration composed, based on the optimal quantity of high-quality bulky feeds with sufficient protein and carbohydrate content, enhances the formation of fatty acids and contributes to the increase in milk fat percentage. Conversely, chronic underfeeding and energy deficiency lead to a decrease in milk fat content (Carrico, J., 2019).

Dairy cows are known to be very prone to negative energy balance (Balasing Rations for Dairy Cattle, 2012; Sarov, A., 2023), especially during periods such as early lactation when feed intake is restricted (FR). Negative energy balance occurs when an animal's energy intake from food, is insufficient to meet its energy requirements. This imbalance can occur naturally, such as dur-

ing early lactation, or it can be induced by environmental factors, such as food scarcity.

An adequate feed intake is an important prerequisite to realize high milk production in dairy cows (Saun, R., 2022). Studying their feeding behavior can help in comprehending the fluctuations in daily intake and enhancing its predictability.

During late pregnancy and early lactation, cows often exhibit reduced voluntary feed intake due to various factors including physical limitations, nervous signals, and hormonal influences (Ingvartsen et al., 1999). This reduction in intake, combined with the high energy demands of lactation initiation, frequently results in a prolonged period of negative energy balance extending into the initial weeks of lactation. The onset of lactation is characterized by heightened energy requirements, due to the rapid increase in milk production, resulting in negative energy balance, mobilization of body reserves, and alterations in milk composition (Bjerre-Harpøth, V. et al., 2012).

Research demonstrates the classical relationship of body condition to dry matter intake, milk production, reproduction, and health. Proper conditioning, then, can be accomplished by body condition scoring, paying close attention to the animals, and ensuring that their nutrient requirements are being met, but not exceeded (Heinrichs J. et al., 2023).

The food policy of the Republic of Moldova consistently emphasizes the importance of milk as a primary source of animal protein. However, national milk production falls short of achieving self-sufficiency. It struggles to match the pace of population growth, resulting in a reliance on imports to meet the demand for dairy products. Furthermore, both the demand for milk and the level of collection have been low in recent times, not fully realizing the potential of national production.

The quality of milk is paramount for all dairy businesses, ensuring the production of healthy, equitable, and marketable products. Any decline in milk quality can significantly impact the final product's quality. Consequently, the resulting products may exhibit average or subpar quality, affecting their processing at dairy facilities, especially considering that these facilities base milk payments on its quality. While few studies have delved into the quality aspect of raw milk, most focus on quantitative measures. It is within this context that the current study aims to emphasize the variety of milk supplied, determined by its chemical composition, volume, and yearly changes in volume.

MATERIAL AND METHODS

Presentation of the study area

This research was conducted in the region of Moldova, within the educational farm of the Technical University of Moldova. The research material comprised a herd of cows during the lactation period. The study period spanned from December to January 2024. All cows of Fleckvieh breed were maintained in a system with free access to feed and water (Photo 1). A survey was carried out involving 14 dairy cows participating in milk quality control. Selection criteria included the availability of reliable and comprehensive information, stable dairy cattle activity, and milk delivery quantities. On the farm, livestock information regarding herd composition, dairy cow characteristics, and feeding management was collected during monthly visits or from milk recordings. Additionally, samples of mixed milk from tank containing milk from dairy herd within the farm were taken.

The analysis focused on female Fleckvieh breed cows with lactation ranks ranging from 1 to 8 and an average rank of 3.5. *Lactations were assessed based on:* total Milk Production (TMP) in kilograms per cow and Technical Average (TA), defined as the average daily production calculated as the ratio of total milk production to calving interval (kilograms per cow per day).

During each of these passages, feed controls have been made. The amount of consumed feed (forage and concentrates) and energy expressed in oat feed unit (OFL), based on the nutritional value of used feed, according to tables published by Pop, I., Halga, P., Avarvarei, T. (2006).

The farm all distributed feed (both forage and concentrates) is carefully weighed. The collected data was utilized to ascertain the amounts of dry matter (DM) and organic feedstuff (OFL) from concentrates consumed per cow during each period, along with determining the proportion of concentrates in the ration, based on their contribution to total energy intake. Likewise, the calculation of the energy value of the concentrates was conducted to determine the number of feed units for lactation (UFL) produced per liter of milk (UFL cc / kg milk).

The main feedstuffs within the livestock farm are: coarse forages (meadow hay, alfalfa hay, and barley straw), succulent forages (corn silage at the milk-wax ripeness stage) and barley hay), cereal concentrates (cornmeal, barley, soybean meal, dried distillers' grains with soluble, and sugar beet molasses).

The productivity of the cows was determined based on the control milking conducted individually for each bovine on the same date monthly. *The criteria for assessing cow supplementation were established as follows*: total energy intake from concentrates for all present cows (Cows present: VP = Σ VP control); OFL cc / kg = Total energy intake from concentrates divided by total milk production (TMP).

Figure 1. Feeding of Fleckvieh breed cows at the Educational Farm of the Technical University of Moldova

Expected milk production (DP exp), calculated based on the nutritional value of rations, was compared to observed milk production (DP obs) to evaluate the impact of concentrate supplementation on milk production enhancement. Body condition (BC) of dairy cows serves, as a reliable and practical tool for assessing nutritional status.

Fourteen cows per farm were monitored and scored by the same observer four times during the study period.

Examination of milk samples

The analyses conducted primarily followed the physico-chemical milk evaluation methods, established locally by the official journal of the Republic of Moldova (Government Decision No.158 of 07.03.2019). The fat content (FC) and density were measured using standard methods. Acidity level (expressed in lactic acid decigrams per liter) was titrated according to official standards and the organoleptic parameters of the milk, were determined based on the methodology described by the researcher Usturoi, M. (2012).

Statistical analysis

The obtained data were processed biometrically and all results were calculated as mean ± standard deviation (SD). Microsoft Excel produced the statistical analysis data.

RESULTS AND DISCUSSION

At the dairy farm of the Technical University of Moldova, cows are primarily fed a diet consisting of high-quality preserved forage, supplemented mainly with concentrates made from corn and barley (Table 1).

In the second recording period, adjustments were made to the feed ration to align with the physiological needs of lactating cows, considering the nutritional content and concentrations of essential nutrients. This adaptation involved incorporating a mixture of roughage and corn silage (Table 2).

After examining the standardized indices, it was concluded that all the parameters outlined in

Table 1. Type and quantity of feeds (as fed) effectively offered in dairy farm

Fodder, kg	Record period	
	1-st period	the 2-nd period
Meadow hay	4,00	5,00
Alfalfa hay	4,00	-
Barley straw	2,00	4,00
Corn silage	-	34,00
Barley haylage	15,00	-
Abomination of corn	2,00	1,80
Barley porridge	1,90	1,60
Borhot distilled from dry corn	1,00	1,70
Sugar beet molasses	1,40	1,90

Table 2. The nutritional value and nutrient concentrations found in the composition of feed rations

Indicators	The concentration of nutrients on record periods	
	1-st period	the 2-nd period
Energy nutritional units	16,82	17,71
Dry substance, kg	20,67	21,91
Crude protein, g	2857,0	2667,70
Digestible protein, g	1860,50	1690,90
Crude cellulose, g	5042,00	5471,60
Starch, g	2148,60	2101,00
Sugar, g	1424,80	1416,50

Table 3 fulfilled the nutritional criteria. As a result, a balance was achieved between sugar and digestible protein, along with the ratio between starch and sugar content.

Whole milk obtained at the didactic farm, is the product of milking dairy cows in hygienic conditions, unmodified in terms of organoleptic and physico-chemical characteristics. Knowing the organoleptic characteristics of milk, gives farm specialists the possibility to detect possible abnormal states of milk. The organoleptic indices of milk are shown in Table 4.

The raw, whole obtained milk is a uniform, milky-white liquid with a subtle yellowish tint, free from any suspended foreign particles or sediments. It exhibits a consistent fluid texture, a mildly sweet taste, and a characteristic milk aroma. No sensory abnormalities were identified during the evaluation.

Assessing the physicochemical attributes of milk is crucial for ensuring compliance with current standards and enables the detection of deliberate adulterations, improper animal feeding practices resulting in milk inconsistencies, or milk sourced from diseased cows.

Milk density, the most variable parameter, is influenced by the ratio of milk concentration to solid substances, non-fat solids, and fat. It inversely correlates with fat content and directly with protein content.

The normal range of milk density fluctuation falls between 27-32°A, with an average value ranging from 29.16-29.26°A during the monitoring periods.

Acidity levels - freshly milked milk tends to exhibit slight acidity. Acidity is measured in Thörner degrees and typically falls within the range of 16-20°T, with the average value over the monitoring period ranging from 16.12-16.32°T. This signifies that the milk maintains satisfactory physical properties in terms of quality.

It was observed that despite consistent maintenance practices for all cows, the body's reaction to external factors translated into variations in both milk quantity and quality. By implementing individualized milking control, the average productivity of each cow was determined, both on a daily and monthly basis.

In the initial observation phase, after conducting control milking, it was determined that there were no notable distinctions between morning and evening milking per lactating cow, with yields ranging from 8.75 to 8.83 kg of milk per cow (Table 5, Figure 2).

This suggests an average daily milk output of 17.58 kg per cow. Subsequently, in the subsequent

Table 3. Examination of feed compositions

Indicators	Nutritional requirements*	Reference data	
		1-st period	the 2-nd period
The content of nutritional energy units per 1kg of dry matter, U.N.E. / kg US	0,85-1,22	1,23	1,23
The amount of dry matter per 100 kg of live weight, kg	2,8-3,8	3,44	3,65
Crude cellulose content per 1kg of dry substance, % / kg	27-24	24,4	24,9
The content of digestible protein per 1 kg of nutritional energy units, g/kg	82-100	110,6	95,5
Digestible sugar-protein ratio	0,80-1,2:1,0	0,76:1	0,84:1
Starch-sugar ratio	1,3-1,5:1	1,5:1	1,48:1

** Kalashnikov et al. (2003)*

Table 4. Sensory characteristics of unprocessed whole milk

Organoleptic indices	The results obtained
Appearance and consistency	Homogeneous liquid without visible impurities in suspension and sediment. Fluid consistency
Color	White, with a slightly yellowish tint, uniform
Smell and taste	Pleasant, sweet characteristic of raw milk

Table 5. The amount of milk obtained per day, kg (n = 14)

Specification		1-st period		the 2-nd period	
		$\overline{X} \pm S\overline{x}$	Limits	$\overline{X} \pm S\overline{x}$	Limitele
Individual control milking	of morning	8,75 ± 2,34	4-16,5	9,82±2,63	5-16,0
	of evening	8,83 ± 2,36	4-14,0	10,55±2,82	5,5-14,0
Average per head/day		17,58 ± 4,70	8,5-27,0	20,37±5,45	10,5-30,0

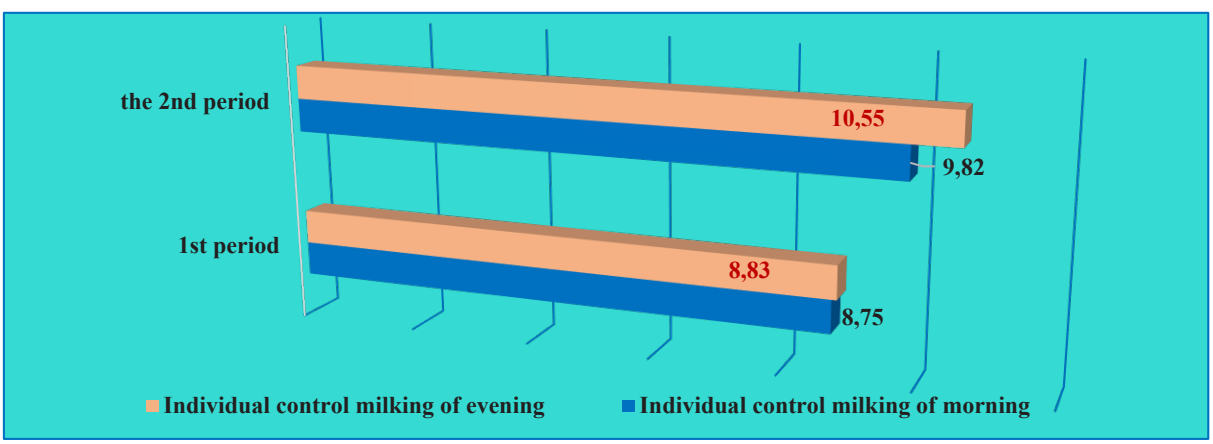

Figure 2. The amount of milk obtained per day, kg

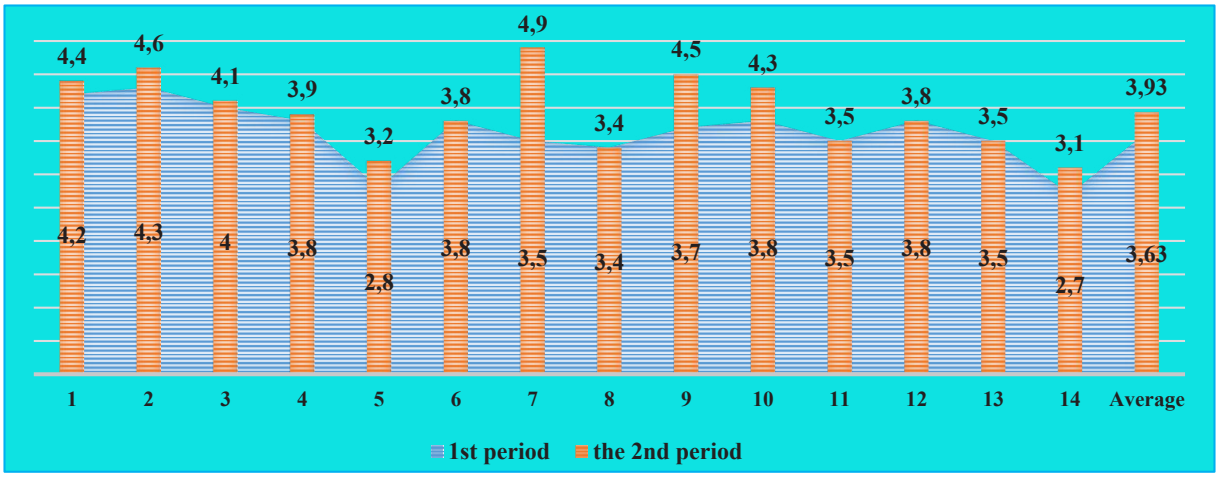

Figure 3. Milk fat percentage, average/head/day, %

observation phase, adjustments to the feed ration resulted in an uptick in average daily milk yield to 20.37 kg per cow. This represents a 2.79 kg increase, or a 15.87% improvement, compared to the initial period.

Milk producers prioritize increasing the volume of milk produced per cow over a given period. However, for commercial milk processors, the percentage composition of milk is of primary concern. This is because any deviations in milk composition must be compensated for during the production of dairy products, such as cheese, where a consistent ratio of specific milk components is crucial in the final product. Therefore, the emphasis should be on the technological properties of milk, particularly its suitability for processing into various products like fermented milk products, cheese, and butter (Harlap, S., Gorelik, A. et al., 2020).

Milk composition can vary significantly, sparking substantial interest in understanding the factors responsible for these differences through numerous studies. Fat content in milk has received greater attention compared to other components due to its higher economic value.

Due to the diversity of its components, cow's milk has a complex chemical composition, which can be represented as follows. The component that contributes the most to the nutritional value of whole raw milk is its fat content, which serves as an energy source for the human body. In raw milk, fat content represents the largest quantitative variations, typically ranging from 3 to 6%.

The fat percentage in whole raw milk averaged across the milking herd at the time of the study (n=14) was 3.63% in the first monitoring period and increased by an additional 0.3% to 3.93% in the second monitoring period, adding value to milk production (Figure 3).

CONCLUSIONS

One of the priorities for ensuring the country's food security is milk production and processing. Feeding lactating cows with balanced rations that meet nutritional requirements and maintain optimal ratios of key nutrients leads to increased qualitative milk productivity.

To increase the workload of dairy enterprises with raw materials, in addition to increasing the number of dairy cows, appropriate feeding should be used since milk processing primarily evaluates the technological qualities of milk and its suitability for the production of certain types of products. Milk indicators, such as fat, protein and lactose content, absence of antibiotics and adulterants, low somatic cell count and microbiological indicators, are of decisive importance. Analysis of milk samples produced at the univer-

sity farm confirms its suitability for processing in terms of fat content.

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