Analysis of Qualitative Milk Parameters on a Dairy Farm in Southern Romania

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Abstract
This study examines the milk production quality of Montbéliarde dairy cows at Moara Domnească farm, in 2024, focusing on key indicators such as fat, protein, lactose, dry matter, and somatic cell count. The study highlights variations in these parameters throughout the year, with factors like diet, season, and cow health influencing the results. Data analysis, including frequency analysis and statistical methods (mean, standard deviation, and coefficient of variation), was used to assess monthly trends. The results show variations in milk quality parameters content, indicating possible dietary imbalances or health issues. The study underscores the importance of maintaining optimal cow health and diet for milk quality and production efficiency.

Keywords: cow, dairy farm, milk quality

1. Introduction

The quality of milk is a very important aspect, both in terms of animal health and food safety for human consumers, through the commercialization and processing of milk into dairy products obtained from the production at any dairy farm.
The values of fat, protein, and lactose in milk are essential indicators of milk quality and cow health. Maintaining these values within normal ranges helps maximize the economic potential of the produced milk and improve the quality of the resulting dairy products. Feeding cows with specific forages and innovative dietary supplements can influence milk production both quantitatively and qualitatively, which can subsequently affect the production and quality of dairy products [1,2].

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The fat percentage in cow's milk typically ranges between 3.5% and 4.5%, depending on diet, season, and the health status of the cows. Milk with an adequate fat content is valued by both consumers and processors, as it is essential for products such as butter, cream, and cheese. The protein content in milk varies between 3.0% and 3.5%. Protein is a key indicator of milk quality and is crucial for cheese production and other dairy products.
Romania's milk production declined in the last years. However, milk collection by processing factories increased, leading to higher dairy product production. This underscores the challenge of maintaining milk quality under economic pressures and feed quality issues [3,4].
Composition of milk (fat, protein, lactose) might not always reflect its true quality for processing. While milk from cows with subclinical mastitis may meet standard compositional criteria, its technological quality—such as clotting time, curd formation, and suitability for cheese production—

can be compromised. These factors are crucial for determining milk's quality for dairy product manufacturing. Therefore, regular SCC analysis helps maintain high milk quality by detecting hidden issues that could affect processing and final product quality [5].

The dairy sector has a major contribution to Romania's economy and the population's nutrition. Studying the milk production potential of cows is essential for the development and optimization of this sector. Given the growing population of Bucharest and the increasing demand for dairy products, understanding and improving the productive capabilities of cows in this region are crucial for ensuring an adequate supply of milk and dairy products.

2. Materials and methods

This study focuses on Montbéliard dairy cows at the Moara Domnească farm in 2024. The Montbéliard breed, originating from France, is known for its high milk production and adaptability. It is part of the dual-purpose milk-beef group and is considered the best milk producer within the Simmental family [6,7].

The cows are housed in a 79.5-meter-long, 9.6-meter-wide shelter with a 2.7-meter ceiling height (5.5 meters at the roof). The shelter has three sections: a resting area, a feeding front, and an access aisle for feed management and waste removal. Cows also have access to an outdoor pen with feeding and watering areas shaded by a canopy.

Milking occurs twice daily: in the morning (5:00-6:30) and evening (17:00-18:30). Milk samples were individually collected from each female, twice a month, over the year 2024. Cows with health issues were removed from the herd, and their milk was not consumed or mixed with the rest of the collected milk. Samples were analysed by the Veterinary Sanitary and Food Safety Laboratory of Bucharest and Laboratory of Foundation for Milk Quality Control, using specific equipment and analytical methods (Milkoscan equipment, FIL IDF 141C:2000, SR EN ISO 13366-2:2007, SR EN ISO 4833-1/2014).

The results of qualitative milk production parameters from the farm during the research period were statistically processed, using numerical techniques, including simple frequency analysis and graphical representation. Statistical analysis was performed with summative indicators of central tendency (mean) and dispersion (standard error of the mean, standard deviation, and coefficient of variation). Also, a Fisher test (analysis of variance - ANOVA) was carried out to determine whether there were significant differences in the milk parameters between the analysed months [8].

3. Results and discussion

Based on these results, monthly averages were calculated, and are presented in Table 1 and Figures 1, 2, 3, and 4.

The highest values for fat and protein were recorded in January (4.58% fat; 3.91% protein), while the lowest were in May (2.48% fat) and July (2.83% protein), respectively. Lactose reached its highest average value in March (4.88%) and its lowest in February (4.55%) (Figure 1).

Fat percentages below 3.5%, recorded in May, June, and July 2023, and protein levels below 3.0% (July – 2.83%) may indicate an unbalanced diet, particularly a deficiency in energy (carbohydrates and fibre) and protein or amino acids in the cows' diet. Additionally, stress or certain metabolic diseases could have contributed to the reduction in fat and protein content.

The only month in which the average fat content exceeded 4.5% was January 2023. This slight increase may indicate overfeeding with energy-rich feed, particularly those high in carbohydrates, and could also be linked to a slight decrease in the total volume of milk produced (the January 2023 average being 7.688 litres, the lowest monthly average for the year).

The variation in milk fat content between months is greater than the variation within each month, meaning that monthly differences in milk fat content are unlikely to have occurred by chance and are statistically significant.

The ANOVA results suggest that there is no significant difference in milk protein content across the periods analysed.

Milk lactose content remained highly stable across all months in 2024, with no significant seasonal fluctuations. This suggests that factors influencing lactose levels, such as diet, lactation stage, and management practices, were consistent throughout the year. Unlike milk fat, which is more sensitive to feed and environmental changes, lactose synthesis in the udder is relatively stable, provided cows receive sufficient energy intake.

Table 1. Fat, protein, and lactose values, from January to December 2024

Parameter / Month	Fat (g/100g) FIL IDF 141C:2000	Protein (g/100g) FIL IDF 141C:2000	Lactose (g/100g) FIL IDF 141C:2000	Non-fat dry matter (g/100g) Milkoscan	Total Dry matter (g/100g) Milkoscan	pH Milkoscan	SCC/ml x1000 SR EN ISO 13366-2:2007
	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$
January	4.58±0.12	3.90±0.06	4.66±0.01	9.27±0.06	13.91±0.15	6.50±0.02	472.41±48.49
February	4.07±0.12	3.52±0.07	4.55±0.04	8.69±0.05	12.93±0.15	6.43±0.02	450.14±37.63
March	4.46±0.12	3.65±0.07	4.87±0.02	9.19±0.05	13.72±0.16	6.45±0.01	352.48±46.35
April	3.72±0.12	3.28±0.08	4.73±0.05	8.82±0.09	12.55±0.20	6.42±0.04	248.92±23.31
May	2.48±0.30	3.55±0.09	4.59±0.08	8.75±0.08	11.34±0.39	6.33±0.04	328.33±.35.10
June	3.21±0.28	3.31±0.05	4.81±0.04	8.95±0.06	12.18±0.24	6.31±0.07	316.75±33.11
July	2.84±0.02	2.83±0.01	4.73±0.03	8.24±0.03	11.13±0.05	6.46±0.01	280.64±16.67
August	4.25±0.32	3.11±0.05	4.78±0.04	8.34±0.05	12.91±0.35	6.11±0.05	563.08±40.44
September	3.93±0.18	3.38±0.05	4.66±0.05	8.57±0.05	12.70±1.10	6.36±0.03	335.07±40.59
October	3.81±0.20	3.52±0.08	4.73±0.03	8.92±0.10	12.54±0.30	6.40±0.04	309.73±42.92
November	4.04±0.18	3.50±0.07	4.72±0.06	8.90±0.09	13.07±0.24	6.43±0.03	350.82±41.00
December	4.50±0.15	3.69±0.10	4.70±0.04	9.05±0.08	13.52±0.22	6.46±0.05	424.23±43.29
Annual average	**3.82±0.19**	**3.44±0.08**	**4.71±0.03**	**8.81±0.09**	**12.71±0.25**	**6.39±0.03**	**369.40±26.14**
Standard deviation	0.67	0.28	0.09	0.31	0.86	0.10	90.54
Coefficient of variation %	17.41	8.15	1.96	3.53	6.73	1.63	24.51
F-value	**2.463**	**0.480**	**0.035**	**0.233**	**28.592**	**21.085**	**8529.769**
p-value (0,05)	**0.006**	**0.914**	**1.00**	**1.00**	**0.001**	**0.001**	**0.001**
F critical	**1.826**	**1.826**	**1.826**	**1.826**	**1.826**	**1.826**	**1.826**
Significance	**statistically significant**	**statistically not significant**	**statistically not significant**	**statistically not significant**	**statistically significant**	**statistically significant**	**statistically significant**

*SCC – somatic cell count

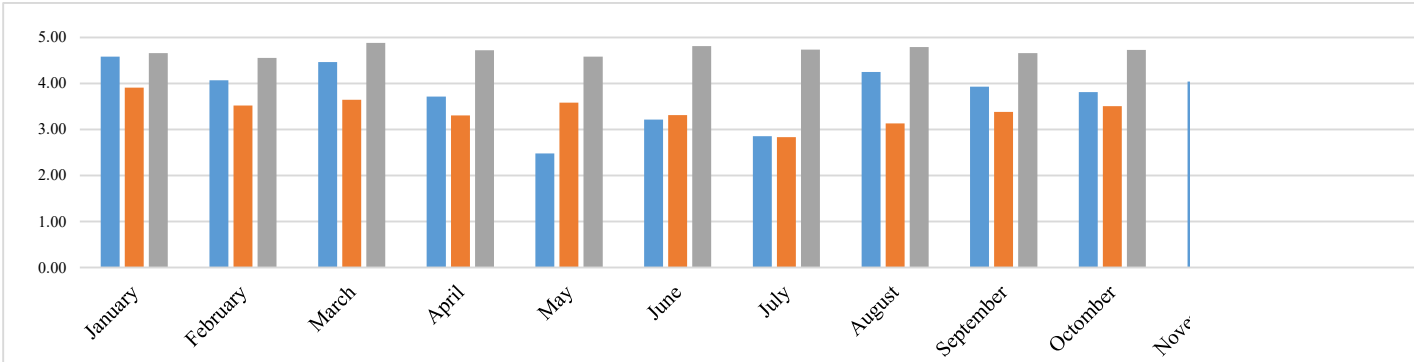

Figure 1. Monthly averages for fat, protein, and lactose from January to December 2024

The highest averages for total dry matter and fat-free dry matter were recorded in January (13.91% and 9.27%, respectively), while the lowest values were observed in July (11.13% and 8.24%, respectively) (Figure 2).

The fat-free dry matter content in milk remained consistently stable throughout 2024, with no significant variations between months. This indicates that key factors affecting fat-free dry matter, including protein, lactose, and mineral levels, were effectively managed and maintained throughout the year. Thus, total dry matter levels fluctuated meaningfully throughout the year and calculated p-value is much smaller than 0.05, this

confirming that the observed differences in total dry matter content across the 12 months are statistically significant.

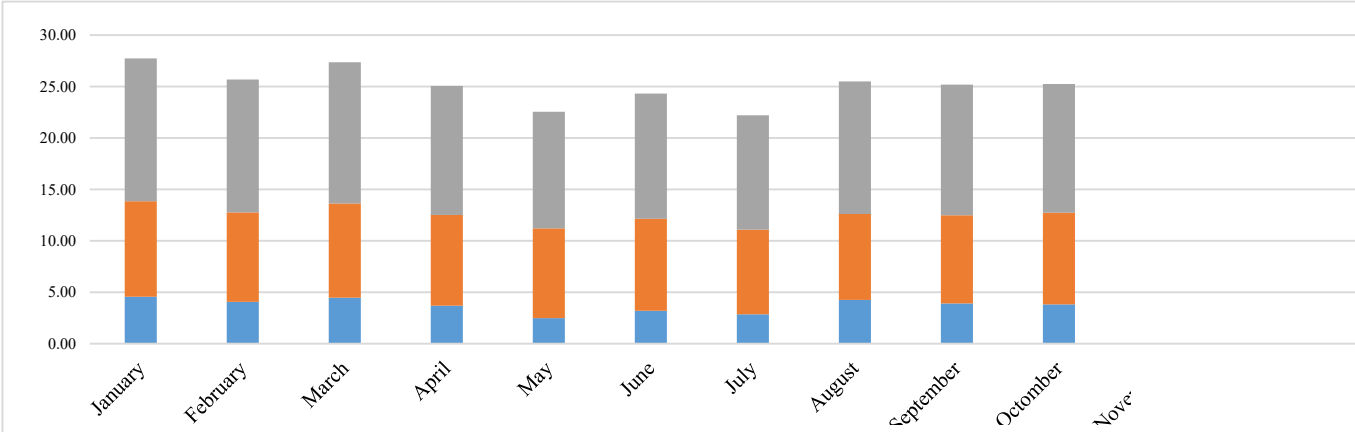

Figure 2. Monthly averages for fat, total dry matter, and non-fat dry matter, from January to December 2024

Regarding the pH, the highest average value was recorded in January (6.50), while the lowest was in August (6.11) (Figure 3).

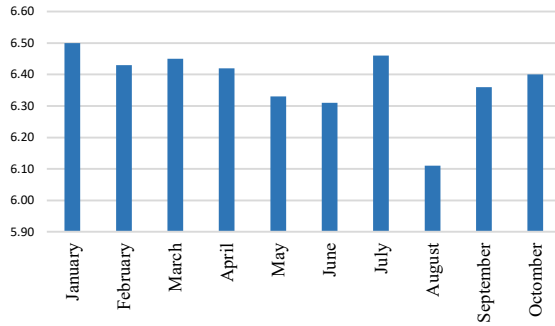

Figure 6. Milk pH from January to December 2024

The sanitary and hygienic properties of milk include indicators such as general bacterial contamination, the presence of inhibitory substances in milk, and the quantitative content of somatic cells. The somatic cell count in 1 ml of milk is one of the most important and informative indicators of milk quality. A certain number of somatic cells is always present in milk, even in healthy cows; however, in the case of udder diseases, the somatic cell count increases.

The recorded values were generally within the accepted limit of a maximum of 400,000 NCS/ml of analysed milk, but there were months when this value was exceeded (January - 472,280 NCS/ml, February - 450,140 NCS/ml, and August - 563,080 NCS/ml). These averages were above the normal limits due to exceptional values from a few cows in the herd. This is also observed through the variability coefficient of 24%, indicating heterogeneous groups of values for this parameter (Figure 4).

The much higher F-value than the F-crit indicates that the variation in pH and somatic cell count (SCC) across the tested periods (e.g. months) is significantly greater than the variation within each period. In these parameters also the p-value is much lower than 0.05. This confirms that these differences are statistically significant.

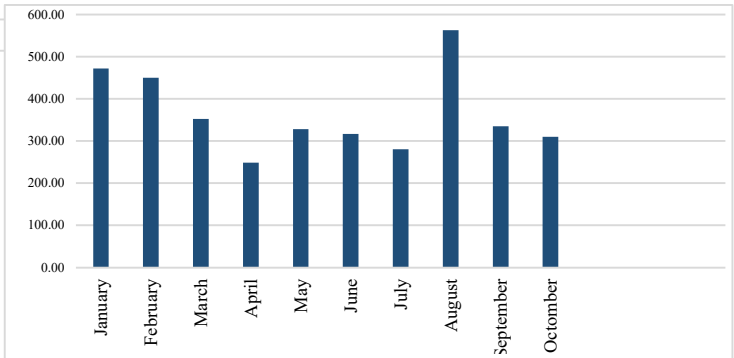

Figure 7. Monthly averages for somatic cell count from January to September 2023

4. Conclusions

Throughout the analysed period, the animal population exhibited monthly (January-December) fluctuations, determined by factors such as the cows' physiological state, the number of calvings and the health status of the herd.

Milk quality generally met standards, with normal levels of fat, protein, and lactose, although some deviations were observed in the milk fat content.

The stability of milk protein and lactose content suggests that feeding and management strategies

provided a consistent protein and energy supply for milk synthesis. However, the significant fluctuations in fat content indicate that diet composition, seasonal influences, or metabolic changes affected fat synthesis more dynamically. To minimize fat variability, fine-tuning feeding programs and managing environmental stressors could be beneficial.

Milk total dry matter content varied significantly throughout 2024, suggesting that external factors such as seasonal feed changes, lactation stages, or environmental conditions played a role in influencing milk composition. Since total dry matter includes both fat and non-fat components, its fluctuations may be primarily driven by the variability in milk fat content, which is more sensitive to diet and seasonal effects.

Somatic cell count was, in most cases, below the maximum accepted limit of 400,000 NCS/ml, due to isolated cases of poor health in some cows, whose milk was not used afterward for consumption.

But significant variation in milk pH and similarly, the statistically significant differences in udder somatic cell count (SCC) suggest that metabolic activity of the cows and microbial activity in the udder varied considerably across the analysed months. An increase in SCC is often linked to mastitis infections, seasonal stressors, or immune responses in dairy cows. These results indicate that certain months may have had a higher prevalence of udder health issues, requiring further investigation into management practices, hygiene, and disease prevention strategies.

To maintain consistent milk quality, it would be beneficial to monitor feeding programs, ensure proper herd health management, and implement preventive measures against mastitis and metabolic disorders.

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