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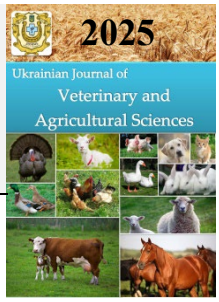

Seasonal fluctuations in individual milk parameters in free-range cows

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Abstract

Understanding milk composition is essential for the Ukrainian dairy industry due to its impact on dairy products' nutritional value, processing characteristics, and functional properties. The drive to achieve high profitability in the dairy industry worldwide has led to different calving models and feeding systems depending on the region's most profitable and efficient form of milk production. This has led to significant regional differences in milk composition. The aim was to analyze individual indicators in raw milk from free-range cows. Their minimum and maximum limits were determined at Komyshuvatskyi Milk Complex LLC, which is key when determining the grade of milk. The content of fat, protein, and somatic cells of raw milk from the farm's industrial herd of cows was analyzed for the period from May 2023 to April 2024. The indicators we selected demonstrated seasonal trends. Significant relationships in the protein-fat system were identified. A decrease in fat content was monitored during the summer period, with the lowest indicator of 3.63 % in July and the maximum of 4.14 % in December. It was found that the average protein index in raw milk was 3.35 %, with a fundamental norm of 3.0, and the peak reached the level of 3.42 between November and January. At the same time, the fat-to-protein ratio in the cows' raw milk did not fall below – 1.14, which proves proper feeding. The average level of somatic cells for the selected period was 245.45 ± 15.72 thousand/cm³. At the same time, this indicator also showed fluctuations, which rose in the winter season to 318.97 thousand cells/ml but did not exceed the established norms according to DSTU 3662:2018 Raw cow milk—technical conditions. The results of veterinary reporting prove that obtaining milk in the conditions of this farm, where well-established work ensures its high quality, may be more suitable for producing various products, including baby food, at different times of the year.

Keywords: milk; seasonality; safety; indicators; fat; protein; somatic cells.

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1. Introduction

The dairy industry of Ukraine is indeed of great economic importance, as it provides the population with essential food products of high biological value. Milk is an indispensable source of proteins, vitamins, minerals, and fats for maintaining human health, especially in young children. Milk also contains useful biologically active substances that ensure optimal body functioning. The growth of demand for dairy products in Ukraine is confirmed by statistical data indicating the stability of milk and dairy product consumption. This indicates the continued importance of dairy products in the diet of citizens, which, in turn, stimulates the development of the dairy industry, milk production, and processing (Bohatko et al., 2012; Timlin et al., 2021; Kotelevych et al., 2023).

Cow, goat, sheep, mare, and camel milk are used for personal consumption and processing (Chen et al., 2023; Kulzhanova et al., 2024).

Milk components are essential for a balanced diet; they are included in diets for such groups of diseases as metabolic disorders, gastrointestinal diseases, liver diseases, and pancreatic diseases (Skeaff et al., 2004). Animal milk consumption is essential to the Mediterranean (MED) diet (Jirillo, 2024). Dairy products, in particular yogurts, kefirs, and acidophilus products, are a source of beneficial bacteria that contribute to the normalization of intestinal microflora (Yatsenko et al., 2016; Zozulia & Symonov, 2018). However, according to the authors, colostrum demonstrates properties that suggest that it can be a practical component in cosmetic or medical compositions for skin care, primarily to support its regeneration, rejuvenation, and wound healing. However, data have been obtained confirming the inhibition

of epidermal keratinocyte viability (Kazimierska et al., 2024).

Thus, the dairy industry is important not only for ensuring food security but also for the health of the nation. The high quality of milk and dairy products directly affects the profitability of the industry and its competitiveness in the domestic and international markets (Mishchenko, 2016). Therefore, for a decade, work has been aimed at understanding and analyzing the leading indicators of the quality of dairy raw materials and their acceptable limits. In recent years, numerous studies have been conducted to assess changes in milk composition. It has been found that several factors are directly or indirectly related to changes in milk composition (O'Sullivan et al., 2019; Zazharska & Kibets, 2020; Mylostyvyi et al., 2021). Thus, the mean density values and standard error of the mean determined for milk samples in each season, i.e., spring, summer, and autumn, were 1.0304 ± 0.00008 g/cm^3, 1.0314 ± 0.00005 g/cm^3, and 1.0309 ± 0.00007 g/cm^3, respectively (Parmar et al., 2020).

The main chemical composition of fresh milk from Polish Holstein-Friesian cows of the black and white breed was investigated in Poland. The higher dry matter, fat, and protein content was found in milk obtained during the lactation extension phase compared to milk from standard lactation (Salamonczyk et al., 2017).

Raw milk samples collected from 24 individual New Zealand cows at the beginning of the season (November), mid-season (January/February), and end of the season (March) showed apparent seasonal differences in mineral and fatty acid profiles. According to the researchers, these were associated with supplementary feeding, the influence of different breeding methods (higher total dry matter content in late-season milk), and the lactation cycle. Targeted metabolite analysis showed increased phosphatase activity in March (Loveday et al., 2021).

In this regard, the *research aimed* to clarify seasonal changes in individual indicators of raw milk of cows kept free of tethers.

2. Materials and methods

The research was conducted on Holstein cattle in LLC "Komyshuvatskyi Milk Complex" conditions, Kharkiv region, Krasnograd district (n = 710). Untethered type of maintenance. On the farm, three milking cows, whose milk productivity was assessed according to the received reports. The average daily milk yield value was calculated as the weighted average for all.

We analyzed the protein content, fat, and the level of somatic cells of raw milk from cows in different seasons of 2023-2024 for compliance with SSTC 3662:2018 Raw cow milk requirements—technical conditions (DSTU ISO 3662:2018, 2019).

During the scientific research, the established laboratory practice norms GLP (1981) and the provisions of the "General Ethical Principles of Animal Experiments," adopted at the First National Congress on Bioethics (Kyiv, 2001), were adhered to. The experiments were conducted following international standards, including the "European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes" (Strasbourg, 1986), "Rules for Conducting Work Involving Experimental Animals", according to the Ministry of Health Order No. 281, dated November 1, 2000, "On Measures for Improving the Organization of Work Involving Experimental Animals", and following the Law of Ukraine "On the Protection of Animals from Cruel Treatment".

3. Results and discussion

Under modern conditions, enterprises' successful financial and economic activity is determined by efficiency, which requires improving information support for production management. Internal management reporting of LLC "Komyshuvatskyi Milk Complex" is a structured form of information presentation. In particular, it contains data characterizing the actual results of the production activity of the enterprise as a whole and in terms of individual structural units, both for the past period and at a specific point in time. According to the provided reporting, the average daily yield per herd for the analyzed period (May 2023 – April 2024) was 20198.43 ± 389.720 kg, of which 95.22 % was delivered to milk processing enterprises. Studies of cow productivity showed fluctuations from 18246.65 to 22541.57 kg.

The obtained data are consistent with the conclusions of researchers who indicate quantitative and qualitative variations in the indicators of milk productivity of animals by season (Begna et al., 2023). Chen et al., 2014; Chen et al., 2015; Li et al., 2019; Cabrera et al., 2024 emphasize seasonal fluctuations in the total composition, chemical composition of protein, size of fat globules, pH and buffer capacity, mineral concentration, and fatty acid profiles of milk.

Seasonal changes in milk indicators are more pronounced for sheep than for goat milk. Given the influence of seasonality, the protein and fat content increased for sheep milk, and the lactose content decreased at the end of the season. The fat, protein, and total dry matter content in goat milk were lowest in summer. Cow's milk also contained the lowest fat content in summer, which the authors attribute to the higher proportion of fresh grass in the diet (Li et al., 2022). This finding is consistent with the results of other scientists. They also observed lower fat content in raw milk from cows grazed on pasture (Elgersma et al., 2004; Couvreur et al., 2006; Hayes et al., 2023).

According to Heck et al. (2009), the concentration of milk fat in milk from the Holstein-Friesian breed increased from a minimum (4.10) in June to a maximum in January (4.57). According to the data we processed, LLC "Komyshuvatskyi Molochnyi Kompleks" increased in December (4.14 %) against a decrease in the indicator in the summer period. Thus, the fat content in July reached 3.63 (Fig. 1). The average fat percentage for the selected season was 3.89 ± 0.05, with a fundamental norm of 3.4 %. The calculated results of milk samples from 17 dairies located in the Netherlands proved that the protein content in milk depended somewhat more on the season, with the lowest content in June (3.21 %) and the highest content in December (3.38 %). The average rate is 3.48% (Heck et al., 2009). According to our generalizations, the average rate is 3.35 ± 0.03 (Fig. 1), decreasing to 3.22 % during June-July 2023.

The fat-to-protein ratio in milk is an essential indicator of the metabolic status of lactating animals, especially cows (Pishchan, 2017). The ratio shown in Figure 2 indicates proper energy balance in cows.

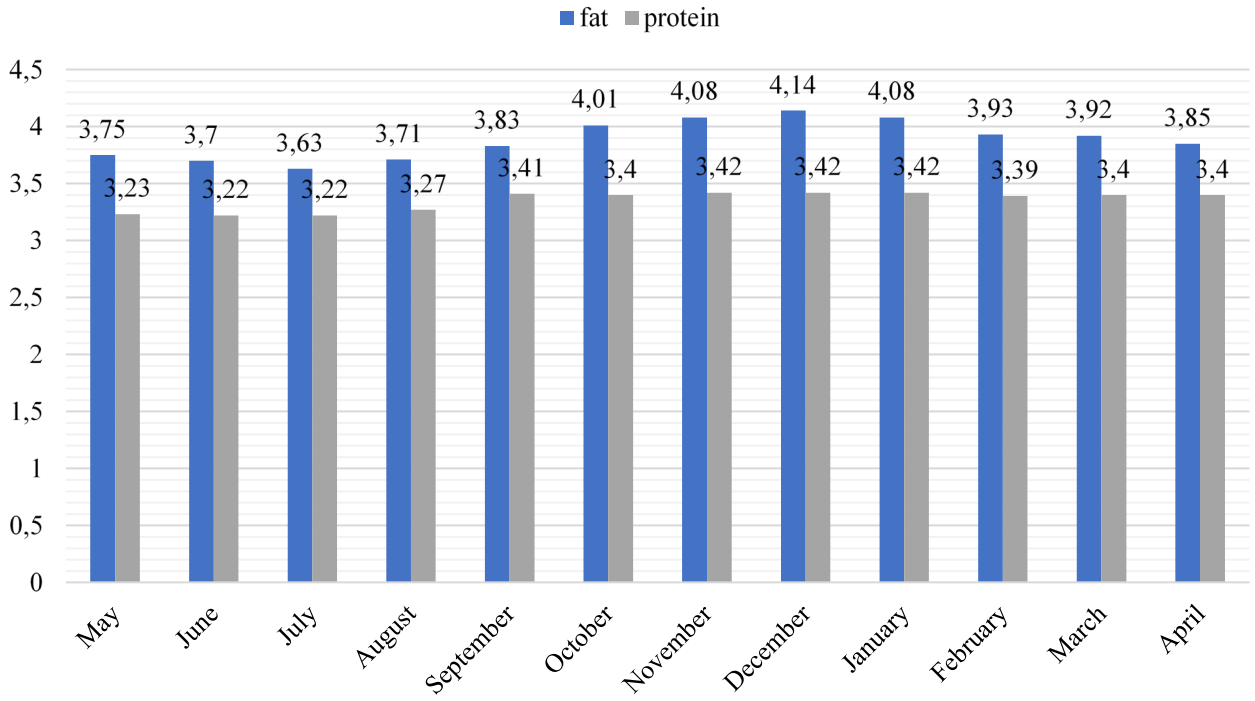

Fig. 1. Monthly fluctuations in fat and protein content in raw cow milk

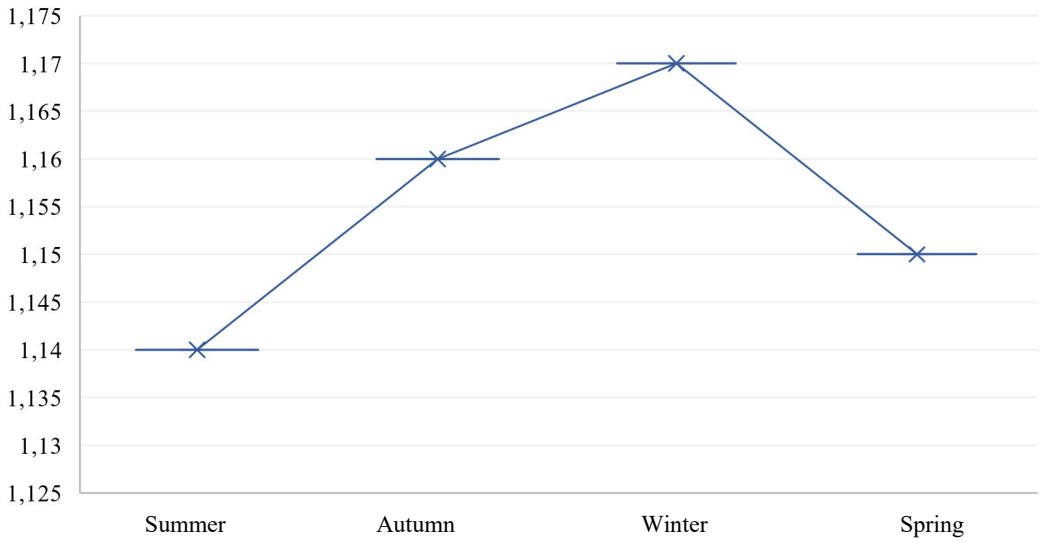

Fig 2. The ratio of fat to protein in raw cow milk in the conditions of Komyshuvatskyi Milk Complex LLC

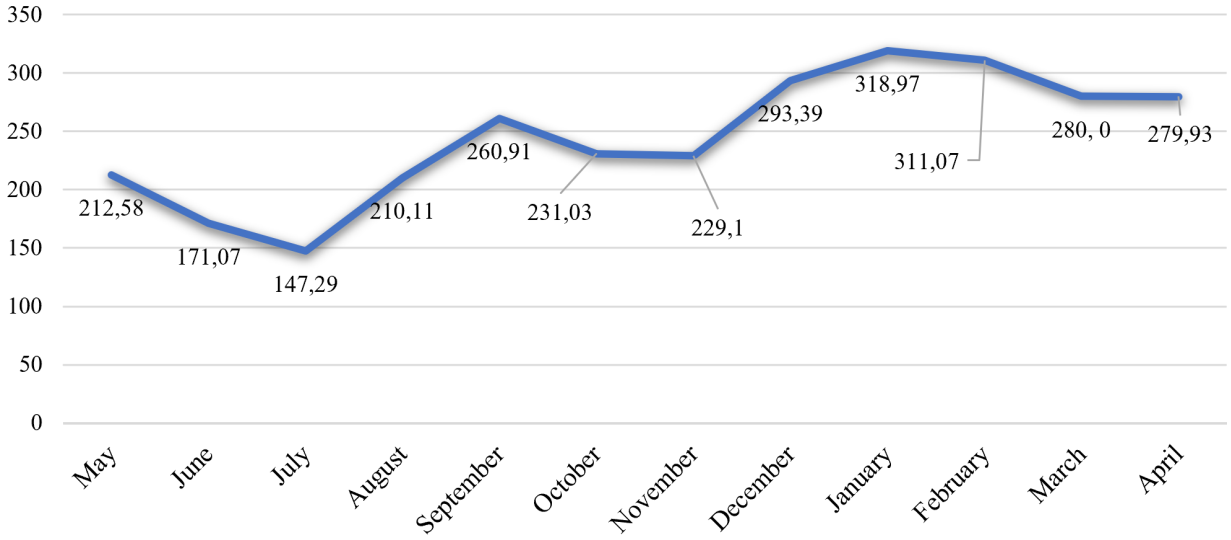

Fig. 3. Monthly fluctuations in somatic cell count in raw cow milk

Analyzing the management reporting forms implemented at Komyshuvatskyi Milk Complex LLC shows that internal reports are usually compiled in tabular, graphic, or text forms. Particular attention is paid to monitoring somatic cells on the farm. Indeed, changes in environmental conditions, poor care, or stressful situations for animals can significantly affect the level of somatic cells in raw milk. Monitoring their level is an essential component of milk safety because the low content of these cells indicates animal health and proper primary processing of raw milk (Bukalova et al., 2022). It should be noted that raw milk with a lower content of somatic cells is preferred by milk processing enterprises, especially in manufacturing baby food. Veterinary reporting of the Limited Liability Company Komyshuvatskyi Milk Complex proves that the level of somatic cells can be controlled. Thus, the average indicator for the selected period was 245.45 ± 15.72 thousand/cm^3 (Fig. 3). We diagnosed an increase in the indicator in January and February 2024, which is consistent with the data of the authors, who noted an increase in the level of somatic cells in the winter-spring period in the conditions of the farm "Ekaterinoslavsky", Dnipro (Zazharska et al., 2024). Foreign scientists also found seasonal changes. The highest indicators were diagnosed from December to March (Marcondes et al., 2014).

No milk is unsuitable for processing on this farm.

4. Conclusion

Limited Liability Company "Komyshuvatskyi Milk Complex", the main activity of which is the production and sale of milk, ensure high quality and safety.

A decrease in fat content during free-range keeping of cows during the summer period was recorded from 3.63 % to 3.71 %.

The protein index in raw milk was found to have the highest index (3.42 %) during November, December 2023, and January 2024.

During the study period, the established number of somatic cells in raw milk from an industrial herd of Holstein breed did not exceed 245.45 thousand/cm^3, which is 38.64 % lower than the approved norms for the milk grade – extra.

Conflict of Interests

The authors declare that they have no conflict of interest.

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