

The Impact of Parity on Dairy Cows Colostrum Quality

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Abstract: One of the main indicators of colostrum quality is represented by its immunoglobulin content, protein molecules responsible for the calf's passive immunity. The objective of this study was to investigate the quality of colostrum according to the concentration of total proteins and γ -globulins, as well as the influence that the number of parturitions has on its quality. Twenty colostrum samples, collected from primiparous (n =10) and multiparous cows (n = 10), from two different dairy cow breeds, were analyzed by the ultraviolet spectrophotometric method. The results of the study showed an increase in colostrum quality depending on the number of parturitions only in cows of the Romanian Black-Spotted breed, γ -globulins concentration increasing from an average of 63,72 g/l in the case of primiparous cows to 116,32 g/l in multiparous cows. In the case of Holstein cows, colostrum quality was not influenced significant by parity. This study underlines the need to expand research on the influence of individual factors on colostrum quality.

Keywords: colostrum; immunoglobulins; parity.

1. Introduction

The colostrum is the secretion of the cow mammary gland during the first days following calving. [1]. It is composed of a range of compounds that are very important to the health and productivity life on calves, including nutritional elements, antimicrobial and growth factors, cytokines, and immunoglobulins [2]. Colostrum composition and quality exhibit significant variability due to multiple factors, including parity, individuality, the duration of the dry period in cows, heat stress [3], gestational nutrition during pregnancy, and the subsequent metabolic and hormonal profiles [4-5], as well as the overall puerperium and its potential complications [6]. The quality of colostrum is characterized by adequate concentration of immunoglobulins, which is essential for the newborn and his immunity, as ruminants are agammaglobulinemic at birth due to the synepitheliochorial placenta [6]. The latter prevents the passage of immunoglobulins, making them vulnerable to infectious disease [7]. Muller and Ellinger [8] concluded that parity determined a significant difference in colostrum IgG content between heifers' offspring and cows' progenies in their third or later parities, emphasizing the importance

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of parity in this regard. To estimate the quality of a colostrum, its IgG content is assessed, researchers suggest that it is qualitative when the content of these immunoglobulins is at least 50g/l [9]. Immunoglobulin values below 50g/l denote an inadequate colostrum in terms of quality and predispose the calf to failure of passive transfer (FPT) [10]. Acquiring passive immunity, the calf depends, in addition to ingesting colostrum in sufficient quantity and quality, on the absorption of immunoglobulins along the intestinal wall before stopping intestinal transport which can vary between 24 to 36 hours after birth [11]. FPT is defined by a serum IgG concentration of <10 mg/ml in neonatal calves aged 24 to 48 h [12-13]. However, thresholds, including the aforementioned value, are highly reliant on the selected technique, with several indirect or direct methods being available for FPT assessment [14-15]. Due to its association with significant economic losses [13], alternative treatments for FPT have been proposed, such as plasma transfusions [16]. However, this approach may present challenges, particularly in finding suitable donors, as intensive testing for highly prevalent pathogens like bovine herpesvirus becomes compulsory [17].

2. Materials and Methods

2.1. Experimental group

A total of 20 dairy cows were involved in this study, sourced from farms in Ilfov County, situated in the southeast region of Romania. To ensure the validity of the findings, the cows were divided into experimental groups. These groups consisted of 10 Holstein breed cows and 10 Romanian Black-Spotted cows, with an equal distribution of each breed, primiparous (n=10) and multiparous (n=10) cows. All cows were scheduled to calve in February 2023. The number of lactations in multiparous females varied between 2 and 4 lactations, and the average milk production for the last lactation was 9867 l for the Holstein cows from the farm 1 and 4337 l for the Romanian Black-Spotted breed, housed at the farm 2. A week before calving, the cows are moved to the maternity area where they are kept until the time of complete recovery. After calving, the calves are separated from the cows immediately after consuming the colostrum.

2.2. Clinical examination

The cows included in the study underwent a brief clinical assessment, during which vital signs were measured, the condition of the mucous membranes was evaluated, and the mammary gland was examined. Thermometric readings revealed body temperatures within physiological ranges, with slightly elevated heart and respiratory rates, which is typical for the final stages of gestation. The mucous membranes exhibited a species-specific color indicative of good health. Upon examination of the mammary gland, no pathological alterations were observed, and there was no tenderness upon palpation, nor were there any temperature irregularities.

2.3. Colostrum sample collection

For the present descriptive study, colostrum samples of 20 cows from two different cattle breeds were collected in sterile vials by farmers in two farms in Ilfov, Romania. Approximately 50 ml of colostrum samples were collected from the first milking after parturition ($3,9 \pm 2,7$ h after parturition; range from 0 to 10 h) and immediately frozen at -20°C until analysis.

2.4. Laboratory Determination of Colostrum Quality

The amount of total proteins, especially immunoglobulins in colostrum is relevant for its quality. Thus, their quantification offers us the possibility of qualitative evaluation of the milk secretion that plays a role in the transmission of passive immunity [18]. The colostrum quality measurement technique used in this study was ultraviolet spectroscopy, a rapid and accurate laboratory-based method [19].

The initial stage in processing the collected samples involved a gradual thawing process, allowing them to thaw slowly at room temperature to prevent protein denaturation. From each thawed sample, a quantity of 10 ml was transferred into Falcon tubes, after which the samples were centrifuged at 3500x g for 5 min to remove the fat layer and isolate whey from the casein pellet. After centrifugation, 0,5 ml of the whey portion was aliquoted from the lower third of the tube and placed in Eppendorf tubes. Subsequently, whey samples were diluted 1:10 with 0,9 % NaCl solution and incubated at 47°C for 10 minutes.

For quantitative determination of Total Protein (TP), 20 µl of each sample was mixed with a Cu 2+ ions-reagent in order to form a chelate with peptide bonds of protein. Subsequently, the sample was incubated for 20 min at 37°C. The quantitative assessment was acquired through analyzing color intensity, a process conducted using a spectrophotometer (Spectrophotometer UV/Vis DLAB SP-UV1000) at a wavelength of 540 nm. To measure the immunoglobulin content of colostrum, a quantity of 20 µl of the sample was mixed with 18,5% Na₂SO₄ solution reagent. The sample was incubated for 15 minutes at a temperature of 37°C. The intensity of the turbidity formed was measured at a wavelength of 450 nm.

3. Results and discussion

3.1. Quality of colostrum samples

The colostrum concentration of immunoglobulin was adequate (≥ 50 g/l) in 90% of samples from primiparous cows. Only one cattle had colostrum of suboptimal quality (< 50 g/l), with a concentration of 48,90 g/l immunoglobulin. In the case of cows with multiple parities, the colostrum quality was of high quality, with γ -globulin concentration varying between 95,90-129,80 g/l, for 90% of calves. Both Holstein and Romanian Black-Spotted, had immunoglobulin concentration above 100g/l, indicating superior colostrum quality.

3.2. γ -globulin concentration variability in relation to parity

In this study, the Holstein breed did not show an increase in colostrum TP or immunoglobulins with the increase in the number of parturitions. Moreover, testing of colostrum samples from multiparous cows indicated lower immunoglobulin concentrations than in first-calving cows, but the number of total proteins was higher compared to primiparous cows (Table 1). Parity, however, seems to cause an increase in the amount of immunoglobulins within the Romanian Black-Spotted. When determining the concentration of colostrum γ -globulins and TP in these subjects, the values of samples from primiparous cows indicated a lower quality colostrum compared to that collected from multiparous cows. Both the number of immunoglobulins and that of total protein increased with the number of parturitions (Table 2).

Table 1. Values of total protein and γ -globulin (g/l) in colostrum samples collected from primiparous and multiparous cows of the Holstein breed.

	PRIMIPAROUS COWS		MULTIPAROUS COWS	
	Total protein	γ -globulin	Total protein	γ -globulin
1	602.6	89.10	420	95.9
2	659	97.10	848	100.2
3	502	101.4	747	104.1

4	1040	139.9	1576	104.6
5	937	152.5	1040	107.1
AVR	748.12	116	926.2	102.38
SEM	205.21	25.28	382	3.92

AVR=Average

SEM=Standard Error of the Mean

Table 2. Values on total protein and γ -globulin (g/l) in colostrum samples collected from primiparous and multiparous cows of the Romanian Black-Spotted breed.

	PRIMIPAROUS COWS		MULTIPAROUS COWS	
	Total protein	γ -globulin	Total protein	γ -globulin
1	310	48.9	1224	109.9
2	350	60.2	1080	108.9
3	366	67.9	1234	112.9
4	552	63.7	1370	120.1
5	724	77.9	1445	129.8
AVR	460.4	63.72	1270.6	116.32
SEM	155.94	9.49	126.59	7.97

The average concentration of immunoglobulins in colostrum from primiparous cows of the Holstein breed was $116 \pm 25,28$ g/l, higher than in the case of multiparous cows of this breed, where the immunoglobulin average was $102,38 \pm 3,92$ g/l (Figure 1). On the other hand, in cows of the Romanian Black-Spotted, the quality of colostrum increased as they had more calvings. The primiparous recorded an average of colostrum immunoglobulins of $62,32 \pm 9,28$ g/l, an amount that was almost double in the milk samples from multiparous, the average concentration in these females being $116,32 \pm 7,97$ g/l (Figure 2).

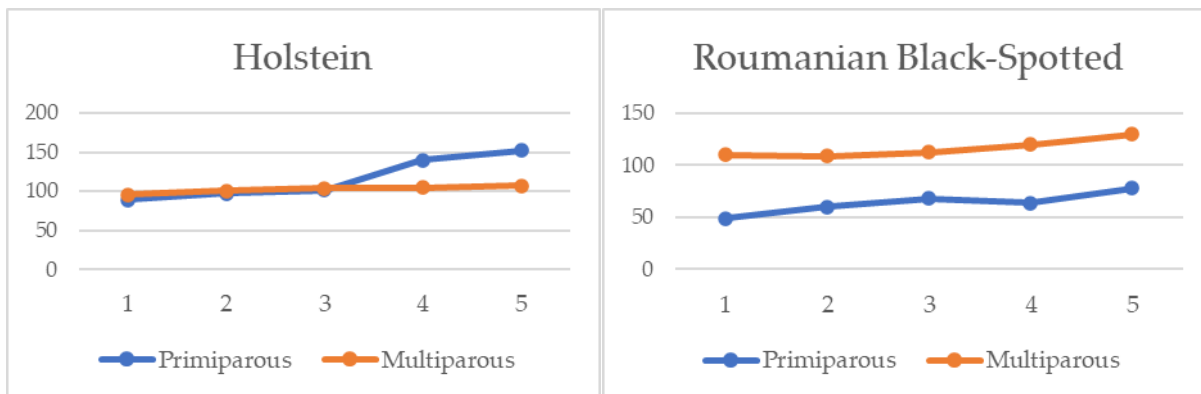


Figure 1 and 2. Graphical representation of the Holstein (1) and Roumanian Black-Spotted breed (2) concentration of immunoglobulins (g/l).

Under the influences of breed, differences were observed in terms of colostrum quality. Primiparous Holstein cows exhibited an average concentration of γ -globulins in the investigated samples of 116 ± 25.28 g/l, significantly higher than that of primiparous cows from the Roumanian Black-Spotted who had an average IgG concentration of 62.32 ± 9.28 g/l at first parturition.

In the case of cows from the Roumanian Black-Spotted breed, the quality of colostrum from multiparous cows has improved, both in relation to primiparous cows from this breed, and compared to cows in their second or third parturition from the Holstein breed, recording average values of 116.32 ± 7.97 g/l immunoglobulins (Figure 3).

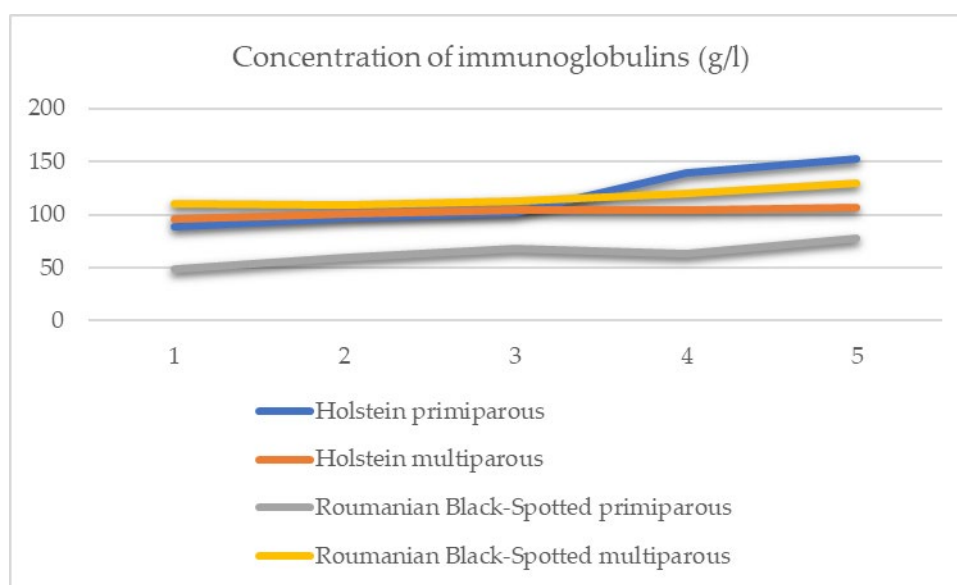


Figure 3. Graphical representation on immunoglobulins values depending on breed and parity

Most studies show that parity has a major impact on the percentage of immunoglobulins in colostrum, research by Muller and Ellinger supports the fact that multiparous cows produce colostrum with a higher number of immunoglobulins than first-calving cows [8] Gulliksen et. al. also confirm that there is a significant difference in colostrum quality between primiparous and multiparous cows [3]. In this study, parity had an influence on colostrum quality only in the farm with cows of the Roumanian Black-Spotted breed, the value of γ -

globulins doubling in multiparous cows. Regarding the Holstein cows studied, the number of parturitions did not affect the improvement of colostrum, the average concentration of immunoglobulins being lower than in the case of primiparous cows of this breed.

Previous studies support the fact that with the increase in the number of parturitions, the quality of the colostrum is also improved. This aspect may suggest the possibility that this increase in the number of immunoglobulins in ruminant colostrum is due to the repeated exposure of these animals to various pathogens, ultimately leading to the formation of antibodies that are transmitted to the mammary gland and from there to the milk secretion [20]. The lower amount of γ -globulins in the colostrum of primiparous cows may be due to the insufficient development of the mammary gland. Older research concludes that the reduced development of the mammary gland hinders the ability of antibodies to pass through, so their milk secretion is poorer in immunoglobulins [21].

4. Conclusions

The main objective of this study was to investigate the influence of parity on colostrum quality. In order to achieve this objective, 20 colostrum samples were taken immediately after calving, from two breeds of dairy cows, both primiparous and multiparous. The quality of colostrum in relation to parity improved significantly in cows from the Romanian Black-Spotted breed, with the amount of γ -globulin quantified from samples from multiparous cows reaching double values compared to females at their first parturition. As for the Holstein breed, the increase in the number of parturitions had no effect on the number of γ -globulins. However, the colostrum quality was adequate, in a concentration above 50g/l in both breeds of dairy cows, regardless of the number of parturitions. Only one female showed concentration of immunoglobulins below the allowed limits.

In conclusion, this study demonstrates the role of parity in improving colostrum quality in cows from the Romanian Black-Spotted breed. Thus, our study underlines the need to expand research on the influence of individual factors on colostrum quality.

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References

1. Jaster, E. H. Evaluation of Quality, Quantity, and Timing of Colostrum Feeding on Immunoglobulin G1 Absorption in Jersey Calves. *J Dairy Sci* **2005**, *88* (1), 296–302. [https://doi.org/10.3168/jds.S0022-0302\(05\)72687-4](https://doi.org/10.3168/jds.S0022-0302(05)72687-4).
2. McGuirk, S. M.; Collins, M. Managing the Production, Storage, and Delivery of Colostrum. *Veterinary Clinics of North America - Food Animal Practice*. W.B. Saunders 2004, pp 593–603. <https://doi.org/10.1016/j.cvfa.2004.06.005>.
3. Gulliksen, S. M.; Lie, K. I.; Sølverød, L.; Østerås, O. Risk Factors Associated with Colostrum Quality in Norwegian Dairy Cows. *J Dairy Sci* **2008**, *91* (2), 704–712. <https://doi.org/10.3168/jds.2007-0450>.

4. Constantin, N. T.; Bercea-Strugariu, C. M.; Bîrțoiu, D.; Posastiuc, F. P.; Iordache, F.; Bilteanu, L.; Serban, A. I. Predicting Pregnancy Outcome in Dairy Cows: The Role of IGF-1 and Progesterone. *Animals* **2023**, *13* (10), 1579. <https://doi.org/10.3390/ani13101579>.
5. Bercea-Strugariu, C.; Constantin, N.; Posastiuc, F.; Andrei, C. R.; Sprințu, I. C.; Micșa, C.; Vlăgioiu, C. The Size and Aspect of Corpus Luteum in Correlation with Progesterone Level in the First Part of the Pregnancy in Dairy Cow. *Rev Rom Med Vet* **2023**, *33* (2), 69–74.
6. Bercea-Strugariu, C.; Constantin, N.; Posastiuc, F.; Crina Raluca; Sprințu, I. C.; Micșa, C.; Vlăgioiu, C. The Influence of the Vulvar-Vaginal Tract Diseases on Bovine Reproductive Activity. *Rev Rom Med Vet* **2021**, *31* (4), 13–20.
7. Geiger, A. J. Colostrum: Back to Basics with Immunoglobulins. In *Journal of Animal Science*; Oxford University Press, 2020; Vol. 98, pp S126–S132. <https://doi.org/10.1093/JAS/SKAA142>.
8. Muller, L. D.; Ellinger, D. K. Colostral Immunoglobulin Concentrations Among Breeds of Dairy Cattle. *J Dairy Sci* **1981**, *64* (8), 1727–1730. [https://doi.org/10.3168/jds.S0022-0302\(81\)82754-3](https://doi.org/10.3168/jds.S0022-0302(81)82754-3).
9. Buczinski, S.; Vandeweerd, J. M. Diagnostic Accuracy of Refractometry for Assessing Bovine Colostrum Quality: A Systematic Review and Meta-Analysis. *J Dairy Sci* **2016**, *99* (9), 7381–7394. <https://doi.org/10.3168/jds.2016-10955>.
10. Marseglia, A.; Pitino, R.; Bresciani, C.; Quarantelli, A.; Righi, F. Measurement of Transfer of Colostral Passive Immunity in Dairy Calves. *Acta Fytotechnica et Zootechnica* **2020**, *23*, 190–196. <https://doi.org/10.15414/afz.2020.23.mi-fpap.190-196>.
11. Mansour El-Loly, M. Mohamed Mansour El-Loly. Evaluation of Colostrum Quality-A Narrative Brief Overview. *Article in International Journal of Immunology* **2022**, *10* (2), 19–24. <https://doi.org/10.11648/j.ji.20221002.12>.
12. Weaver, D. M.; Tyler, J. W.; VanMetre, D. C.; Hostetler, D. E.; Barrington, G. M. Passive Transfer of Colostral Immunoglobulins in Calves. *Journal of veterinary internal medicine / American College of Veterinary Internal Medicine*. 2000, pp 569–577. <https://doi.org/10.1111/j.1939-1676.2000.tb02278.x>.
13. Godden, S. Colostrum Management for Dairy Calves. *Veterinary Clinics of North America: Food Animal Practice* **2008**, *24* (1), 19–39. <https://doi.org/10.1016/j.cvfa.2007.10.005>.
14. Constantin, N. T.; Posastiuc, F. P.; Andrei, C. R.; Sprințu, I. C.; Băraităreanu, S. Indirect Passive Transfer Evaluation Techniques in Calves: A Review. *Rev Rom Med Vet* **2023**, *33* (4), 97–101.
15. Popescu, A. D.; Posastiuc, F. P.; Constantin, N.-T.; Marian, F.; Codreanu, M. D. Comprehensive Evaluation of Direct Methods for Failure of Passive Transfer Diagnosis in Neonatal Calves. *Cluj Veterinary Journal* **2024**, *29* (1), 26–37. <https://doi.org/10.52331/nqpej009>.
16. Constantin, N. T.; Posastiuc, F. P.; Andrei, C. R.; Sprințu, I. C.; Ionescu, T. Ștefan; Băraităreanu, S. Blood Processing in Cattle: Insights for Alternative Therapies. *Rev Rom Med Vet* **2023**, *33* (3), 46–50.
17. Constantin, N. T.; Posastiuc, F. P.; Andrei, C. R.; Geicu, O.; Iordache, F.; Stanca, L.; Bilteanu, L.; Serban, A. I. Bovine Herpes Virus Quantification by Qpcr in the Blood of Asimptomatic Late-Term Cows. *Scientific Works. Series C. Veterinary Medicine* **2023**, *69* (2), 41–46.
18. Ahmann, J.; Steinhoff-Wagner, J.; Büscher, W. Determining Immunoglobulin Content of Bovine Colostrum and Factors Affecting the Outcome: A Review. *Animals*. MDPI December 1, 2021. <https://doi.org/10.3390/ani11123587>.
19. Elsohaby, I.; McClure, J. T.; Cameron, M.; Heider, L. C.; Keefe, G. P. Rapid Assessment of Bovine Colostrum Quality: How Reliable Are Transmission Infrared Spectroscopy and Digital and Optical Refractometers? *J Dairy Sci* **2017**, *100* (2), 1427–1435. <https://doi.org/10.3168/jds.2016-11824>.
20. Donovan, G. A.; Badinga, L.; Collier, R. J.; Wilcox, C. J.; Braun, R. K. Factors Influencing Passive Transfer in Dairy Calves. *J Dairy Sci* **1986**, *69* (3), 754–759. [https://doi.org/10.3168/jds.S0022-0302\(86\)80464-7](https://doi.org/10.3168/jds.S0022-0302(86)80464-7).
21. Devery-Pocius, J. E.; Larson, B. L. Age and Previous Lactations as Factors in the Amount of Bovine Colostral Immunoglobulins. *J Dairy Sci* **1983**, *66* (2), 221–226. [https://doi.org/10.3168/jds.S0022-0302\(83\)81780-9](https://doi.org/10.3168/jds.S0022-0302(83)81780-9).