Bovine Colostrum Management and the Factors Influencing its Quality

Adina-Mirela Ariton,[1] Andra-Sabina Neculai-Văleanu,[1] Ciprian Radu,[1] Ioana Porosnicu,[1,2] Elena Ungureanu[2]

[1] *Research and Development Station for Cattle Breeding Dancu, Iaşi - Ungheni Alley No. 9, 707252, Iaşi, Romania*
[2] *University of Life Sciences, Mihail Sadoveanu Alley No. 3, 700490 Iasi, Romania*

Abstract

The mammary gland's secretion, called colostrum, is synthesized throughout the last weeks of pregnancy and the first few days following calving. It is meant to give the calf the necessary nutrients and physiologically active substances. High immunoglobulin concentration and low pathogen load define high-quality colostrum. The amount and quality of colostrum that is available and the timing of the first feeding after birth both have an impact on the level of immunity. Heifers produce substantially less colostrum than cows do, and the breed has a big impact as well. Colostrum handling and storage techniques, as well as milking procedures are essential steps toward quality colostrum management on dairy farms. This review focuses on colostrum management, methods, and techniques for assessing colostrum quality and the factors that influence bovine colostrum quality.

Keywords: Bovine colostrum, IgG concentration, management, quality.

1. Introduction

The most crucial management aspect for calf survival and health is colostrum management. There is a chance for many dairy farmers to enhance their colostrum management techniques, which will benefit the animals' performance and short- and long-term health. For the first few hours of life, producers must provide calves with an adequate amount of high-quality colostrum [1,2].
Animal rearing is one of the most challenging phases of life, and the most delicate time is immediately following birth.
Colostrum is the first mammary gland secretion after delivery. It provides a comprehensive nutritional profile and bioactive substances essential for appropriate nutrition as well as fostering the growth, development, and immune defence of newborns) [3].

* Corresponding author: Adina-Mirela Ariton, 0746029138, amariton@yahoo.ro

According to Moore et al. (2009) [4], a healthy cow can generate 5 to 10 L of colostrum every milking, colostrum being referred to as "Liquid Gold" [5,6].
Bovine colostrum is made up of a combination of lacteal secretions and blood serum components, namely Ig and other serum proteins that build up in the mammary gland throughout the dry prepartum period. This procedure starts weeks beforehand.
Colostrum contains cytokines, vitamins, peptides, leukocytes, hormones, minerals, and oligosaccharides in addition to growth factors, lactoperoxidase, lysozyme, lactoferrin, and other substances. All of these substances, with the exception of lactose, drop quickly during the first three days of breastfeeding before changing into mature milk [2].
These elements participate in a variety of biological processes, such as the development of the gastrointestinal tract, immunological function, energy homeostasis, and defense against infections [7].

For the best start for newborn calves and to guarantee adequate transfer of passive immunity, optimal on-farm colostrum management is crucial. To determine the best colostrum feeding management practices, numerous studies have been undertaken [8].

The objective of the present study was to conduct a large-scale investigation of the factors affecting colostrum management and to present the content of the major components of colostrum and the methods of assessing its quality.

2. Methods of monitoring quality colostrum

Radial immunodiffusion (RID), despite being expensive and time-consuming, is the best method for evaluating the IgG level of colostrum. Using a Brix refractometer to assess the total solids concentration to ascertain the amount of IgG present in colostrum is an indirect but reliable, practical, and straightforward cow-side method [9].

In comparison to cows producing high-quality colostrum, somatic cell count, which was assessed after calving, is considerably greater in cows producing inferior colostrum. Also, it is preferable to determine the amount of colostral IgG indirectly using a colostrometer (50 g IgG/l = density of 1045) or a brix refractometer (50 g IgG/l = 21–22 Brix).

Colostrum taken more than two hours after calving had a much-reduced concentration of colostral IgG, likely as a result of dilutional effects and the fact that colostral Ig passively diffuses into the cow's systemic circulation [6,10]

Inadequate colostrum management techniques, including colostrum feeding procedures and on-farm colostrum storage procedures, may have an impact on the immunological components of colostrum and, consequently, the newborn calf's immune condition.

3. Discussion

The factors influencing the quality of bovine colostrum

Based on the volume of colostrum produced or its appearance, the farmer finds it challenging to determine the quality.

Most researchers have focused on the immunological quality of colostrum and the factors affecting it, as it ensures the passive transfer of immunity and calf protection from a wide range of infectious diseases until they are capable of producing their own antibodies at 3 to 6 weeks of age [9].

When it comes to the quality of the colostrum that is produced, the level of feeding and the surroundings in which the cows are maintained before to calving are crucial [11].

Immunoglobulin G (IgG) content is affected by several factors including breed, age and parity of the dam, length of the dry period, vaccination schemes [16], colostrum yield [12], and the time between calving and colostrum collection [13,14].

Most studies reveal that older cows tend to produce higher-quality colostrum, probably as a result of their extended exposure to farm-specific infections. Colostrum from cows in their first and second lactations in research by Shivley and colleagues [15] had similar colostrum quality, however, colostrum from older and third-lactation cows had better quality [9].

Lacetera et al. [16] reported that cows supplemented with injections of selenium and vitamin E in late pregnancy produced a greater volume of colostrum than supplemented cows when all cows were fed a prepartum diet that was deficient in vitamin E and selenium. Aragona aet al. reported that supplementation with nicotinic acid for 4 weeks prepartum increased IgG concentration in colostrum [1].

Additionally, colostrum contains immunologically active leukocytes, fat, protein, water-soluble vitamins (such as niacin, thiamine, riboflavin, vitamin B12, pyridoxal, pyridoxamine, and pyridoxine), minerals (such as calcium, magnesium, manganese, potassium, sodium, iron, copper, sulphur, and zinc), and non-specific antimicrobial factors (such as lactoferrin) gain additional healthy components in higher concentrations than regular milk [10].

When calves are taken from their mother during the first three hours of birth, the chances of passive transfer failing are higher than when calves are allowed to nurse their dam. When let to nurse, calves consume too little and late colostrum.

The likelihood of failure of passive transfer is significantly reduced by giving calves as much colostrum as they want via nipple bottle between 1-4 hours of birth and at 12 hours of age. Tube feeding should be used for bottle-fed calves who refuse to consume colostrum on their own.

When colostrum is given once via oesophageal intubation 2 hours after birth, feeding at least 150 to 200 g of colostral IgG is necessary for adequate passive transfer of colostral IgG [17,18].
Colostrum quality should be assessed as previously mentioned in order to estimate the precise amount of IgG supplied to a calf: if colostrum contains 50 g IgG/L, feeding 4 L of colostrum is sufficient to provide 200 g IgG to the calf. A risk factor for FPT is hand-feeding colostrum more than four hours after birth [19]. Comparing bottle-fed calves getting 2 L of colostrum to those receiving 4 L by oesophageal intubation, there was a modest delay in the rise of serum Ig concentration.
The use of an oesophageal tube to feed 4 L of colostrum is a safe and reliable method for an adequate passive immune transfer in healthy newborn calves due to the difference in administered volume (4 L versus 2 L) between the two methods (oesophageal intubation versus bottle-fed) [10,20].
Colostrum is typically kept refrigerated for a brief length of time, resulting in almost no nutrient loss during storage (protein, total solids, minerals, and lactose), but it needs special handling and careful thawing for appropriate function.
The freezing procedure attempts to maintain the quality of colostrum for potential use in calves in crucial situations, such as when the mother's production of colostrum is poor, there is not enough of it, or the mother has died in severe cases.
In this regard, studies on colostrum preservation have been found in the literature employing a variety of methods, including freezing, pasteurization, lyophilization, chemical additions, and refrigeration [21].
Colostrum's IgG concentration declines in time, so it should be milked as soon as possible. To lessen bacterial contamination, colostrum should be pasteurized in small batches for 30 or 60 minutes at a temperature of no more than 60 C. The freezing and thawing of colostrum have no or very little effect on IgG concentrations as long as the process is done au bain-marie and the temperature does not exceed 40°C.
Pasteurization is a useful technique for lowering colostrum bacterial contamination. Colostrum cannot be pasteurized at the usual milk pasteurization temperatures because doing so would cause the IgG to be partially destroyed and cause the colostrum to thicken [22].
It is advised to pasteurize colostrum for 60 minutes at 60°C. The shelf life of pasteurized colostrum in a clean, covered container in the refrigerator is 8 to 10 days.
According to studies, calves who consume pasteurized colostrum have much greater serum levels of IgG than calves who consume non-pasteurized colostrum [21,22].

4. Conclusions

Colostrum handling and storage procedures, administration strategies, and milking procedures were all described as important steps. Colostrum should be milked as soon as possible because the IgG concentration in it diminishes over time. To minimize bacterial contamination, colostrum should be pasteurized in small batches for 30 or 60 minutes at a temperature of no higher than 60°C.
Colostrum has properties that support the healthy functioning of the immunological and endocrine systems in addition to its own regulatory function, which fuels the development of the growing organism.
Both individual characteristics and environmental factors, such as parity, prepartum nutrition, season, breed, duration of the dry period, immunization of the dam, delayed colostrum collection, abortions, or cow health, contribute to the variation in colostrum quality.

References

1. Sandra, M., Godden, D..VM., Lombard, J.E., Woolums, A.R., Colostrum Management for Dairy Calves, Vet Clin North Am Food Anim Pract., 2019, 35(3): 535–556.
2. Playford, R.J., Weiser, M.J., Bovine colostrum: its constituents and uses, Nutrients, 2021, 13:265
3. Linehan, K., R. Paul, Ross, R.P., Stanton, C., Bovine Colostrum for Veterinary and Human Health Applications: A Critical Review, Annual Review of Food Science and Technology, 2023, 14:387-410.
4. Moore, M., Chigerwe, M., Dawes, M.E., Tyler J.W., Middleton J.R., Effect of delayed colostrum collection on colostral IgG concentration in dairy cows, J. Am. Vet. Med. Assoc., 2005, 226, 1375-1377.
5. Kuralkar, P., Kuralka, S.V., Nutritional and Immunological Importance of Colostrum for the new born, Veterinary World, 2010, 3(1):46-47.
6. Ariton, A.M., Neculai-Văleanu, A.S., Poroșnicu, I., Ungureanu, E., Trincă, L.C., Quality Assessment of

Bovine Colostrum and Possible Applications in the Dairy Industry, Animal Science and Biotechnologies, 2023, 56(1).
7. Lopez, A.J., Heinrichs, A.J., Invited review: the importance of colostrum in the newborn dairy calf, 2022, J. Dairy Sci. 105:2733–49.
8. Robbers, L., Jorritsma, R., Mirjam Nielen M., Koets, A., Scoping Review of On-Farm Colostrum Management Practices for Optimal Transfer of Immunity in Dairy Calves, Front. Vet. Sci., Sec. Animal Nutrition and Metabolism, 2021, 8 – 2021.
9. Soufleri, A., Banos G., Panousis, N., Fletouris, D., Arsenos, G., Kougioumtzis, A., Valergakis, G.E., Evaluation of Factors Affecting Colostrum Quality and Quantity in Holstein Dairy Cattle, Animals, 2021, 11(7).
10. Meganck, V., Hoflack, G., Opsomer, G., Advances in prevention and therapy of neonatal dairy calf diarrhoea: a systematical review with emphasis on colostrum management and fluid therapy, Acta Veterinaria Scandinavica, 2014, 56, 75.
11. Puppel, K., Gołebiewski, M., Grzegorz, Grodkowski, G., Jan Slósarz, J., Kunowska-Slósarz, M., Solarczyk, P., Łukasiewicz, M., Balcerak M., Przysucha, T., Composition and Factors Affecting Quality of Bovine Colostrum: A Review, Animals 2019, 9, 1070.
12. Morin D.E., Nelson S.V., Reid E.D., Nagy D.W., Dahl G.E., Constable P.D. Effect of colostral volume, interval between calving and first milking, and photoperiod on colostral IgG concentrations in dairy cows. *J. Am. Vet. Med. Assoc.*, 2010, 237:420–428.
13. Gulliksen, S.M., Lie, K.I., Sølverød, L., Østera, O., Risk, Factors Associated with Colostrum Quality in Norwegian Dairy Cows, J. Dairy Sci. 2008, 91:704-712.
14. Conneely, M., Berry, D.P., Sayers, R., Murphy, J.P., Lorenz, I., Doherty, M.L., Kennedy, E., Factors associated with the concen-tration of immunoglobulin G in the colostrum of dairy cows, Animal, 2013, 7:1824–1832.
15. Shivley, C.B., Lombard, J.E., Urie, N.J., Haines, D.M., Sargent, R., Kopral, C.A., Earleywine, T.J., Olson, J.D., Garry, F.B., Preweaned heifer management on US dairy operations: Part II. Factors associated with colostrum quality and passive transfer status of dairy heifer calves. J. Dairy Sci. 2018, 101:1–14.
16. Lacetera, N., Bernabucci, U., Ronchi, B., Effects of selenium and vitamin E administration during a late stage of pregnancy on colostrum and milk production in dairy cows, and on passive immunity and growth of their offspring, Am J Vet Res., 1996, 57:1776–1780.
17. Chigerwe, M., Tyler, J.W., Schultz, L., Middleton J.R., Steevens B.J., Spain J.N., Effect of colostrum administration by use of oroesophageal intubation on serum IgG concentrations in Holstein bull calves. Am. J. Vet. Res., 2008, 69:1158–1163.
18. Trotz-Williams, L.A., Leslie, K.E., Peregrine A.S., Passive immunity in ontario dairy calves and investigation of its association with calf management practices. J Dairy Sci., 2008, 91:3840–3849.
19. Beam, A.L., Lombard, J.E., Kopral, C.A., Garber, L.P., Winter, A.L., Hicks, J.A., Schlater, J.L., Prevalence of failure of passive transfer of immunity in newborn heifer calves and associated management practices on US dairy operations, J. Dairy Sci. 2009, 92:3973–3980.
20. Sakai, R.R., Coons, D.M., Chigewe, M., Effect of single oroesophageal feeding of 3 L versus 4 L of colostrum on absorption of colostral IgG in Holstein bull calves, Livest Sci., 2012, 148: 296.
21. Schogor, B., Luiza, A., Glombowsky, P., Both, F., Danieli, B., Rigon, F., Reis, H., Da Silva, J., Aleksandro, S., Quality of bovine colostrum and its relation to genetics, management, physiology and its freezing, Revista MVZ Córdoba, 2020, 25, 1.
22. Luiza, B.A., Glombowsky, P., Both, F., Danieli, B., Rigon F., Reis, J.H., Da Silva, A.S., Quality of bovine colostrum and its relation to genetics, management, physiology and its freezing, Rev. MVZ Córdoba, 2020, 25(1):e1465.