The influence of colostrum consumption on serum lactoferrin in newborn calves

Ioana MINEA (căs. PIPIRIG)*, Elena VELESCU, Cristina HORHOGEA
Faculty of Veterinary Medicine from Iasi, Aleea Mihail Sadoveanu nr. 8, 700489, Iaşi, România
*corresponding author: e-mail: yoana.minea@gmail.com

Abstract
Lactoferrin is a glycoprotein from the transferrin family, proteins capable of binding and transferring Fe^{3+} ions. Lactoferrin from bovine colostrum and milk has become increasingly important due to its wide range of biological properties. Colostrum intake leads to increased serum lactoferrin levels in calves [11], foals [2] and piglets [5]. Together with IgG, it is transferred from the intestinal tract into the systemic circulation through passive absorption in the case of newborns. Fewer studies have been performed in animals, but it has been shown to reduce morbidity and improve the growth rate of calves [9]. Studies have also indicated that lactoferrin can lead to the elimination of pathogens and therefore to the reduction of the incidence of neonatal diseases through the mechanism of iron binding, inhibition of bacterial growth and proteolytic activity [1].
Key words*: calf, colostrum, lactoferrin, passive transfer.*

Introduction

Lactoferrin was first isolated from Sorensen's bovine milk in 1939. It is the largest protein fraction in whey and is present in various physiological fluids, including plasma, tears, saliva, vaginal fluid, semen, nasal, lacrimal and bronchial secretions, biliary secretion, gastrointestinal fluid, urine, synovial and amniotic fluid, plasma and neutrophil granules. Lactoferrin has multiple properties, among the most important being antimicrobial, immunomodulatory and anti-inflammatory. Lactoferrin has been extensively researched in humans, primarily in infants and young children, and there is evidence that lactoferrin reduces the severity and longitudinal prevalence of diarrhea [8].

Some authors reported a mean lactoferrin concentrations of 1.96 ± 0.27 mg / ml in the colostrum of 45 Holstein cows [12], while others reported an average of 0.34 ± 0.23 mg / ml for 6 cows by chromatography [13]. High amounts of lactoferrin, ranging from 1 to 5 mg / ml, are found in bovine colostrum [10]. Lactoferrin is significantly influenced by the number of lactations ($r = 0.555$) and daily milk production ($r = –0.472$) [3]. As an antimicrobial protein, lactoferrin produced by the mammary gland can have a dual role, protecting both the mammary gland as well as the intestine of newborn calves.

Some researchers have suggested that there was no evidence between colostrum absorption and serum lactoferrin levels [6], while others reported that they found serum lactoferrin levels before colostrum absorption and that they are about 5 times lower than colostrum levels measured at 24 h in calf serum [4]. Moreover, these researchers showed a progressive decrease in serum lactoferrin levels from the first day until the end of the first month of calf life.

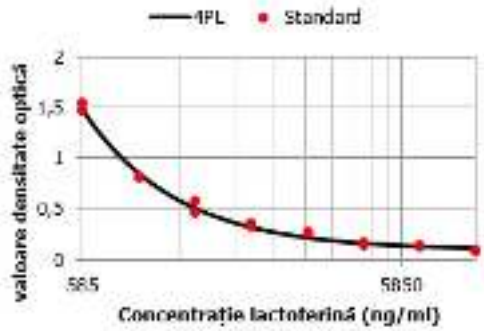
The aim of this study was to observe variations in serum lactoferrin concentrations following the intake of freshly harvested colostrum and administered to calves in the first hour of life.

Material and methods

In order to conduct the study, between November 2019 and January 2020, 42 samples of calf serum were collected and tested immediately after birth and 42 serum samples every 24 hours after colostrum administration. Calves were given freshly harvested colostrum from their mothers immediately after calving.

For the analysis of serum and colostrum lactoferrin, the Lactoferrin Bovine Bio-X Diagnostics Competition Elisa kit was used, which uses microplates sensitized with bovine lactoferrin-specific polyclonal antibodies. The samples are incubated concomitantly with a specific enzymatic conjugate consisting of chemically peroxidase-bound purified bovine lactoferrin. For the quantitative evaluation of lactoferrin in the samples a calibration curve obtained using dilutions from a known concentration of bovine lactoferrin using the Four Parameter Logistic Curve program (log-log) was used (figure 1).

The testing of the samples was performed within the FMV Iaşi immunology laboratory. Descriptive statistics and intra-group comparisons were performed using IBM SPSS Statistics Subscription and Microsoft Office Excel.



a	-0.1589
b	0.5852
c	660.5
d	5.945
MSE	0.006227
R^2	0.9885
SS	0.04359
SYX	0.1205

Fig. 1 – Standard calibration curve for the calculation of lactoferrin concentrations

Results and discussions

The statistical results of the analyzes performed are shown in Table 1.

Table 1.

Lactoferrin concentrations following colostrum consumption in newborn calves

	Colostrum (mg/ml)	Calf serum day 0 (µg/ml)	Calf serum day 1 (µg/ml)
$\bar{X}$±SD	0,67 ± 0,42	2,68 ± 1,05	5,24 ± 1,87
SE	0,10	0,30	0,42
Minim	0,15	0,25	2,70
Maxim	1,40	3,97	9,05
CI 95%	0,22	0,67	0,87
p value	calf serum day 0 – calf serum day 1: p< 0,0001.		

In the 40 colostrum samples, the mean value of colostrum lactoferrin was 0.67 ± 0.42 mg / ml, with a maximum value of 1.4 mg / ml and a minimum of 0.15 mg / ml (Table 1). The mean serum lactoferrin concentration on day 0 (2.68 µg / ml) increased approximately 2 times a day after colostrum intake (5.24 µg / ml, Table 3.4). Similarly, some authors showed low serum lactoferrin (1.09 µg / ml) in newborn calves immediately after birth, which increased approximately 10-fold to 8 hours after the first colostrum and thereafter it gradually decreased until the second day of life [7]. These authors suggested that the tendency to increase serum lactoferrin concentrations was

most likely caused by its absorption from colostrum. A relatively low concentration of lactoferrin in the blood plasma of calves at birth (0.20 µg / ml) increased approximately 10-fold at 6 hours after the first colostrum intake, but these higher concentrations were sustained only in the first 12 hours of life [11]. The increasing trend of bovine serum lactoferrin concentration observed in the present study one day after lower colostrum intake compared to the results of the authors mentioned above, could be influenced by the biological activity of absorbed colostrum lactoferrin, which is rapidly metabolized in the blood of calves approximately 12 hours after colostrum intake [7].

The concentrations of lactoferrin found in the blood of newborns are dependent on the concentration of lactoferrin in the ingested colostrum and the amount of colostrum administered [3]. To test this hypothesis, we set up 2 experimental groups, depending on the averages of the colostrum lactoferrin concentrations obtained, namely:

- Group 1 - colostrum lactoferrin concentrations between 0.15-0.2 mg / ml, with an average of 0.4 mg / ml, 28 cows, 30 calves;
- Group 2 - colostrum lactoferrin concentrations between 1.1-1.4 mg / ml with an average of 1.18 mg / ml, 12 cows, 12 calves.

The mean serum lactoferrin concentration in group 2 was significantly higher than in group 1 ($p < 0.03$, figure 2). This result confirms that lactoferrin in the blood of newborns is dependent on the concentration of lactoferrin in ingested colostrum, as as some authors suggest [3].

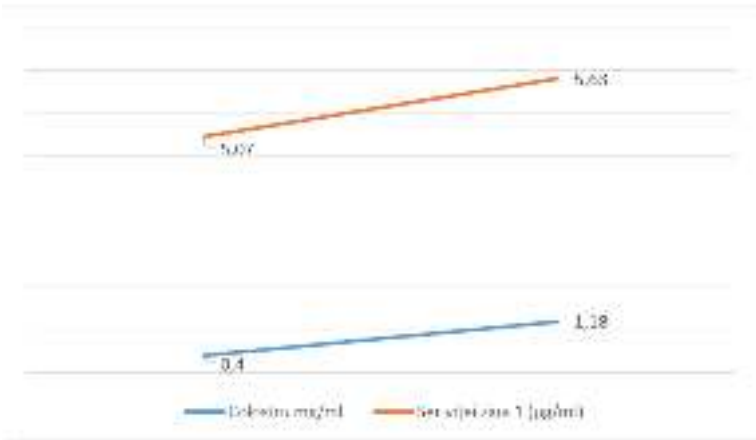


Fig. 2 - Influence of colostrum lactoferrin concentrations on serum lactoferrin in newborn calves

Conclusion

The obtained results showed that following the administration of colostrum, the serum lactoferrin concentration increased discreetly but significantly (calf serum day 0 - serum calf day 1 $p < 0.0001$). We also found that a higher concentration of colostrum lactoferrin causes a higher concentration of serum lactoferrin in calves 24 hours after colostrum administration. In conclusion, the results obtained showed significant changes in serum lactoferrin concentrations which reflects the calves' response to colostrum intake.

References

6. Adlerova L, Bartoskova A, Faldyna M. 2008. Lactoferrin: a review. Vet Med Czech. 53:457–468
7. Barton M.H., Hurley D., Norton N., Heusner G., Costa L., Jones S., Byars D., Watanabe K. (2006): Serum lactoferrin and immunoglobulin G concentrations in healthy or ill neonatal foals and healthy adult horses. Journal of Veterinary Internal Medicine, 20, 1457–1462

8. Cheng J.B., Wang J.Q., Bu D.P., Liu G.L., Zhang C.G., Wei H.Y., Zhou L.Y., Wang J.Z. (2008): Factors affecting the lactoferrin concentration in bovine milk, Journal of Dairy Science, 91, 970–976.
9. Dawes, M.E., Latrikz, J., Tyler, J.W., Cockrell, M., Marsh, A.E., Estes, D.M., Larson, R.L., Steevens, B. (2004). Effects of supplemental lactoferrin on serum lactoferrin and IgG concentrations and neutrophil oxidative metabolism in Holstein calves. J Vet Intern Med, 18, 104-108.
10. Harada E., Y Itoh, K Sitizyo, T Takeuchi, Y Araki, H Kitagawa - Characteristic transport of lactoferrin from the intestinal lumen into the bile via the blood in piglets, Comp Biochem Physiol A Mol Integr Physiol, 1999 Nov;124(3):321-7. doi: 10.1016/s1095-6433(99)00122-1.
11. Holloway, N. M., J. W. Tyler, J. Lakritz, S. L. Carlson, R. K. Tessman, and J. Holle - Serum immunoglobulin G concentrations in calves fed fresh colostrum or a colostrum supplement., 2002, Vet. Intern. Med. 16:187–191
12. Hurley W, Sixiang Z - Absorption of colostral lactoferrin in newborn calves., 2000, Illini DairyNet Papers 11/15
13. Ochoa, T. J., E. Chea-Woo, N. Baiocchi, I. Pecho, M. Campos, A. Prada, G. Valdiviezo, A. Lluque, D. Lai, and T. G. Cleary. 2013. Randomized double-blind controlled trial of bovine lactoferrin for prevention of diarrhea in children. J. Pediatr. 162:349–356
14. Robblee, E. D., P. S. Erickson, N. L. Whitehouse, A. M. McLaughlin, C. G. Schwab, J. J. Rejman, and R. E. Rompala. 2003. Supplemental lactoferrin improves health and growth of Holstein calves during the preweaning phase. J. Dairy Sci. 86:1458–1464
15. Stelwagen K., E. Carpenter, B. Haigh, A. Hodgkinson, T. T. Wheeler – Immune components of bovine colostrum and milk, Journal of Animal Science, Volume 87, Issue suppl_13, April 2009, Pages 3–9, https://doi.org/10.2527/jas.2008-1377.
16. Talukder MJ, Harada E. - *Binding characteristics and distribution of lactoferrin receptors in the gut and choroid plexus in newborn calves*. Indian J Exp Biol. 2006;44(10):783–790. [PubMed] [Google Scholar]
17. Tsuji, S., Y. Hirata, and F. Mukai. - Comparison of lactoferrin content in colostrum between different cattle breeds, 1990. J. Dairy Sci. 73:125–128
18. Yoshida, S., Z. Wei, Y. Shinmura, and N. Fukunaga. 2000. Separation of lactoferrin-a and -b from bovine colostrum. J. Dairy Sci. 83:2211–2215.