EVALUATION OF COLOSTRUM QUALITY AND NEW POSSIBILITIES FOR ITS APPLICATION

Jelena Zagorska[1*], Indra Eihvalde[2], Ilze Gramatina[1], Svetlana Sarvi[1]

[1]Latvia University of Agriculture, Department of Food Technology, Liela street 2, Jelgava, LV3001, Latvia
**e-mail: jelena.zagorska @.llu.lv*
[1]Latvia University of Agriculture, Research and Study Center, Akademijas street 11[A], Auces district, LV-3708, Latvia

Abstract

Colostrum is the secretion from the mammary gland during the first 24 h after calving and is an important source of nutritional, growth, and antimicrobial factors for a newborn calf. –Despite the importance of nutrients in colostrum, published data describing bovine colostrum composition in Latvia is extremely limited. Most researches, investigating colostrum, focuses narrowly on the total concentration of immunoglobulins (Ig) and ignores other nutrients, and separate Ig concentrations; therefore the aim of the present study was to evaluate quality of colostrum.–A total 29 samples of colostrum were collected from the conventional farm located in Auce. The experiments were carried out in the Latvia University of Agriculture. The content of protein and fat, and pH detected according to the standard methods. Concentrations of IgA, IgG, IgM were determined by turbodynamic method. The data were processed by using the SPSS software package SPSS 11.0. and MS EXCEL. Research results show, that the concentration of separate nutrients is significantly different compared with data from literature. Due high nutritional value, particularly increased concentration of immunoglobulins, colostrum may find beneficial application in new functional food development.
Key words: colostrum, chemical composition, immunoglobulins.

Introduction

Colostrum is the secretion from the mammary gland during the first 24 h after calving (Jaster, 2005) and is an important source of nutritional, growth, and antimicrobial factors for a newborn calf. It is well documented that colostrum of good quality (i.e., containing high levels of Ig) fed as soon as possible after birth is a necessity to decrease disease susceptibility and neonatal mortality (Wittum and Perino, 1995). Colostrum contains high levels of immunoglobulins, which play an important role in establishing passive immunity in the young calf, and play an important role at the localized intestinal level (Jaster, 2004).

Colostrum contains 3 types of Ig, IgG, IgM, and IgA, where IgG accounts for more than 75% of the total (Korhonen et al., 2000). There are 3 types of Ig in colostrum of dairy cattle: IgG, IgM, and IgA, which typically account for about 85 to 90, 5, and 7%, respectively, of total Ig in colostrum (Roy, 1990). To be classified as colostrum of satisfactory quality, international recommendations set a minimum concentration of 50 g of Ig g l^{-1}, based on studies showing significantly higher rates of low serum Ig concentrations in calves receiving colostrum with an IgG content below this limit (Besser et al., 1991).

Colostrum quality varies distinctly among different factors: as individual features, breeds, parity, health status of the cow (Dardillat et al., 1978, Gulliksen et al., 2008).

Management and feeding of high-quality colostrum can reduce calf mortality, strengthen immunity, and increase animal life span (Quigley and Drewry, 1998). Delaying the intake of colostrum reduces passive transfer of Ig and postpones provision of essential nutrients that supplement the meager reserves in the bovine neonate. The composition of colostrum is important in satisfying the nutritional requirements of neonatal dairy calves, particularly for nutrients that only minimally cross the placenta (Kehoe et al., 2007). Calves also require fat and protein for energy and muscle development in the first days of life, as well as growth factors and many other nutrients that are concentrated in the first lacteal secretions of the dam postcalving (Roy, 1990; Quigley and Drewry, 1998).

At the same time increasing antibiotic resistance among pathogens gives emphasis to the need to develop new means to prevent diseases by nutritional intervention. Modulation of the gastrointestinal flora has turned out to be an integral part of health promotion. It is suggested

that combining bovine milk or colostral Igs with probiotic lactic acid bacteria could provide considerable prospects for health promotion in the future (Mehra et al., 2006).
Despite the importance of nutrients in colostrum, published data describing bovine colostrum composition in Latvia are extremely limited. Most researches, investigating colostrum, focus narrowly on the total concentration of immunoglobulins (Ig) and ignore other nutrients, and separate Ig concentrations; therefore the aim of the present study was to evaluate quality of colostrum.

Materials and Methods

A total 29 samples of colostrum were collected from the conventional farm "Ligotnes" located in Auce. The experiments were carried out in the Latvia University of Agriculture. The content of lactose, protein and fat, density, and pH were detected according to the standard methods (see Table 1). Immunoglobulins (IgA, IgG, IgM) concentrations were determined by turbodimetric method (Грант, 1973).

Table 1

The standards of analysis

Parameter	Number of samples	Standard
The content of lactose	29	LVS ISO 5765–1:2003
The content of protein		LVS EN ISO 8968–5:2002
The content of fat		LVS EN ISO 8968–5:2002
Density		LVS 186:1999
pH		LVS EN ISO 6092: 2003

Colostrum from the first milking was collected and freezed immediately after calving. The samples were taken from a healthy quarter. The individual ID number of each cow and the calving date was registered for each colostrum sample. The aim of the study was not to evaluate the influence of factors as cow's breed (Latvian Brown 76%, Holsteins Black 10% and Danish Red 14%), lactation number (e.g. 1.–6.), season (summer, winter), and feed (was equal for all cows) on the colostrum composition and quality, therefore it was not taken into consideration in this publication.
Samples were analyzed at least in duplicate. The data was processed by using the SPSS software package SPSS 11.0. and MS EXCEL.

Results and Discussion

As was mentioned previously, calves require fat and protein for energy and muscle development in the first days of life (Roy, 1990, Quigley and Drewry, 1998), therefore the content of this nutrient in colostrum is extremely important. The findings of our study were compared with the concentrations reported by Kehoe et al. (2007), the one of the last published review of colostrum composition. The compositional analysis of colostrum content is presented in Table 2.

Table 2

Compositional analysis of the first milking colostrum

Parameter	Mean ± SE	Minimum	Maximum	Data from literature (Kehoe et al., 2007)
Fat, %	6.48±2.90	1.50	11.75	6.70
Protein, %	16.30±3.89	8.48	22.68	14.92
Lactose, %	3.67±0.72	2.51	5.80	2.49
Total solids, %	27.06±5.38	17.27	35.69	27.64
Density, kg m^{-3}	1043.97±9.40	1022.00	1057.00	–
Total Ig, g l^{-1}	19.40±7.23	8.01	37.24	34.96

Mean content of fat in colostrum was 6.48±2.90%, the results of the research relate to the data from previous studies, where fat content was slightly higher – 6.70%, (Kehoe et al., 2007), but significant difference was not established. The content of fat in colostrum is less likely to be affected by keeping and feeding conditions: high quality feed, well balanced and rich in cellulose, not chopped, in sufficient amount was available promote higher content of fat in colostrum.

The content of protein in colostrum was in very wide range from 8.48 to 22.68%. Mean protein content was 16.30±3.89% and it was similar to the data from other report (Kehoe et al., 2007).

The content of lactose in colostrum was in very wide range from 2.51 to 5.80%. Mean content of lactose was 3.67%, it was significantly higher comparing with other author report ($p<0.05$) – 2.49% (Kehoe et al., 2007). Higher concentration of lactose should be evaluated negatively, because this fact does not coincide with the physiology of the neonate calf, in which lactase is found in low concentrations at birth (Zabielski et al., 1999), it means, that in this case digestion of lactose is quite difficult for calf.

Immunity is provided to neonatal calves by passive immunity derived from colostral Ig ingested and absorbed during the first 24 h of life (Stott et al., 1979). Therefore the most significant factor affecting colostrum's quality is concentration of Ig. Concentration of Ig in colostrum ranged from 8.01 to 35.69 g l^{-1}. Mean concentration of Ig was 19.40 g l^{-1}, it was significantly lower than those in the previous research – 34.96 g l^{-1} (Kehoe et al., 2007). To be classified as colostrums of satisfactory quality, international recommendations set a minimum concentration of 50g of IgG l^{-1} (Besser et al., 1991), it means, that there were not colostrum samples analysed in current research, which could be classified as colostrum of satisfactory quality.

The concentrations of individual classes of immunoglobulin are shown in Fig. 1 and Fig. 2.

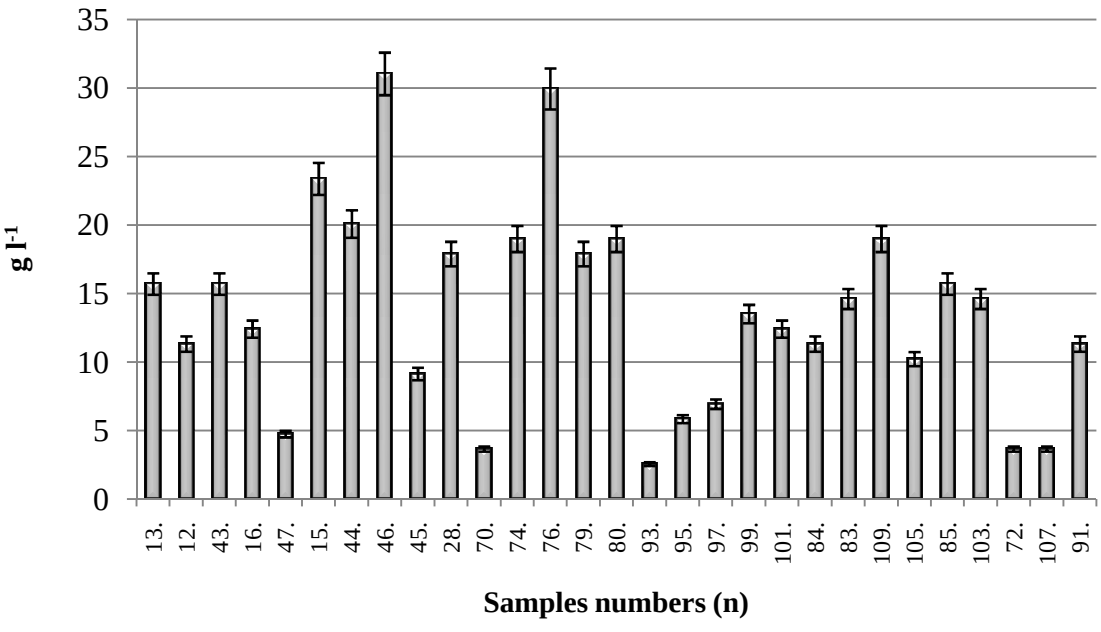

Figure 1. Concentration of IgG in the first milking colostrum

The concentration of IgG in colostrum ranged between 2.55 to 31.03 g l^{-1}, mean concentration of IgG was 13.65±7.32 g l^{-1}, which was significantly lower than the data reported by Pritchett et al. (1991) found an average of 48.2 g l^{-1} for IgG1 and Kehoe et al. (2007) – 40.96 g l^{-1} for IgG.

The volume of colostrum produced, parity, dry period length, vaccination, and many other factors have been reviewed and have been reported to affect the IgG content in colostrums (Kehoe et al., 2007). Any of these factors may have played a role in accounting for the low IgG content in colostrum in the current research, but for stricter conclusion about factor significantly decreasing IgG concentration and about possibility to increase the concentration of IgG in colostrum in the future, the research in this area should be done.

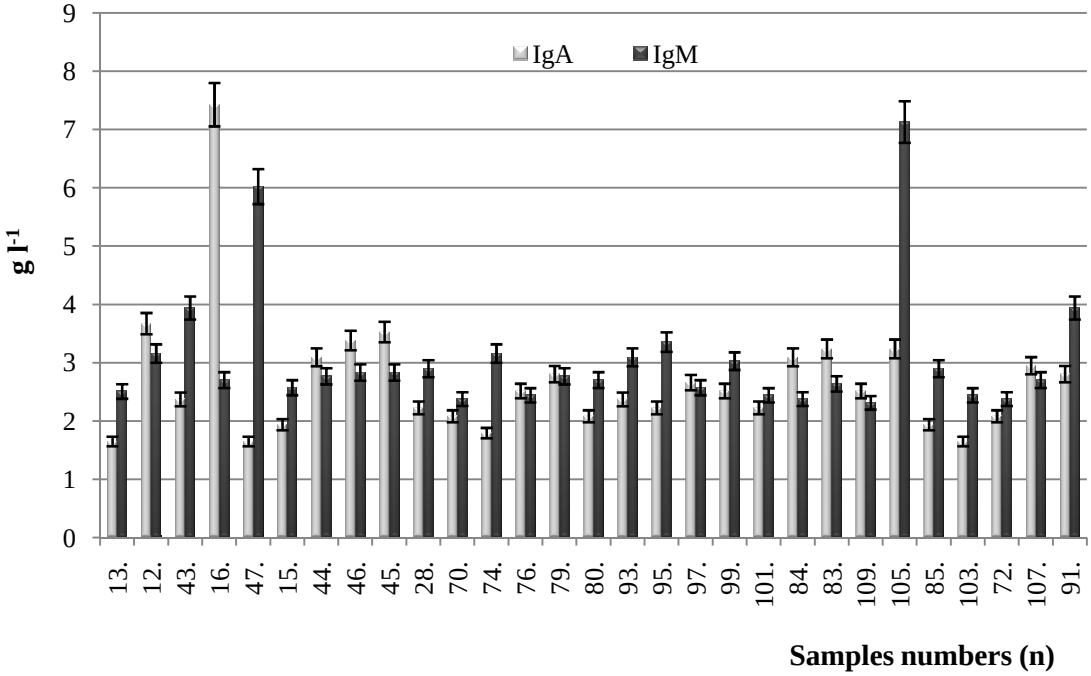

Figure 2. Concentration of IgA and IgM in the first milking colostrum

Conversely results were obtained after evaluation mean concentrations of IgA. Concentrations of IgA in the current study were significantly higher than the report by Kehoe et al. (2007) – 1.66 g l^{-1}. In the current study, mean concentration of IgA was 2.67±1.08 g l^{-1}. The higher concentration of IgA could be explained with significant cow's immunity fortification influence.

Mean concentrations of IgM was 3.03±1.08 g l^{-1}, it was lower than the report by Kehoe et al. (2007) – 4.32, but it fall within the range of literature values because of the high variation of IgM concentrations, ranged from 3 to 12 g l^{-1}.

Table3

Immunoglobulin concentration in the first milking colostrum and milk

Immunoglobulin class	Colostrum, g l^{-1}	Milk, g l^{-1}
IgG	13.65±7.32	0.63±0.006
IgA	2.67±1.08	0.13±0.001
IgM	3.03±1.08	0.08±0.001
Ig total	19.40±7.23	0.84±0.080

The concentration of Ig, independent from Ig class, was significantly higher in colostrum comparing with milk (see Table 3). This increased pool of immunoglobulins can be enriched further through concentration techniques, leading to production of Ig products containing high antibody concentration. Such preparation may find beneficial application as in human healthcare and wellbeing by preventing infection and controlling diseases, as in new functional food development.

Conclusions

1. The mean concentration of main nutrients (fat – 6.48±2.90% and protein – 16.30±3.89%) in colostrum was according to the data from the literature. Since these components are necessary for energy and muscle development in the first days of life the high concentration of them are extremely important and significant.
2. Significantly higher mean content of lactose in colostrum (3.67%), comparing with data from the literature, evaluated negatively – the digestion of lactose for calf is more difficult.
3. Mean concentration of IgG was 19.40 g l^{-1}, it was significantly lower to be classified as colostrum of satisfactory quality.
4. Due high nutritional value, particularly increased concentration of immunoglobulins, colostrum may find beneficial application in new functional food development.

Acknowledgment

This research has been prepared within the framework of the ESF Project „Formation of the Research Group in Food Science", Contract Nr. 2009/0232/1DP/1.1.1.2.0/09/APIA/ VIAA/122.

References:

1. Besser, T., Gay, C., Lori, C. (1991) Comparison of three methods of feeding colostrums to dairycalves. *JAVMA*, Vol 198, No 3, pp. 419–422.
2. Dardillat, J., Trillat, G., Larvor., P. (1978) Colostrum immunoglobulin concentration in cows: Relationship with their calf mortality and with the colostrum quality of their female offspring. *Ann. Rech. Vet*., 9, pp. 375–384.
3. Gulliksen, S., Lie, I., Sųlverųd, L., Ųstera, O. (2008) Risk Factors Associated with Colostrum Quality in Norwegian Dairy Cows. *J. Dairy Sci.*, Vol. 91, No. 2, pp. 704–712.
4. Jaster, E., (2005) Evaluation of Quality, Quantity, and Timing of Colostrum Feeding on Immunoglobulin G1 Absorption in Jersey Calves. *J. Dairy Sci.*, Vol 88, No1, pp 296–302.
5. Kehoe, S., Jayarao, I., Heinrichs, B. (2007) A Survey of Bovine Colostrum Composition and Colostrum Managment Practise on Pennsylvania Dairy Farms. *J. Dairy Sci.*, Vol. 90 No 9, pp. 4108–4116.
6. Korhonen, H., Marnila, P., Gill, H. (2000) Milk immunoglobulins and complement factors. *Br. J. Nutr*., Vol. 84, pp. S75–S80.
7. Mehra, R., Marnila, P., Korhonen, H. (2006) Milk immunoglobulins for health promotion. *International Dairy Journal* 16, pp.1262–1271.
8. Quigley, J., Drewry, J. (1998) Nutrient and immunity transfer from cow to calf pre- and postcalving. *J. Dairy Sci*. 81, pp. 2779–2790.
9. Roy J. (1990) Immunity to disease. In: *The Calf*. 5th ed., Vol. 1. Butterworths, SAS Institute. Cary, NC, pp. 17–52.
10. Stott, G., Marx, D., Menefee, B., Nightengale. G. (1979) Colostral immunoglobulin transfer in calves I. Period of absorption. *J. Dairy Sci*., 62, pp. 1632–1638.
11. Wittum, T, Perino , L. (1995) Passive immune status at postpartum hour 24 and long-term health and performance of calves. *Am .J. Vet. Res.*, 56, pp. 1149–1154.
12. Zabielski, R., Huerou-Luron, I., Guilloteau, P. (1999) Development of gastrointestinal and pancreatic functions in mammalians (mainly bovine and porcine species): Influence of age and ingested food. *Reprod. Nutr. Dev*., 39, pp. 5–26.
13. Грант, Х. (1973) Турбодиметрический способ количественного опредиление лизоцима с применением спектрофотометра СФУА, *Лабораторное дело*. (Turbodimetric method for determination of lysozyme by means of spectrophotometer SFUA, A Laboratory manual), Х. Грант, Л.И. Яворковский, И.А. Блумберга (ред.), 300–304 стр. (In Russian).