Acta Univ. Sapientiae, Alimentaria, 4 (2011) 18–27

Colostrum and milk of current and rare cattle breeds: protein content and amino acid composition

J. Csapó[1,4]
email: csapo.janos@ke.hu

K. Lóki[1]
email: loki.katalin@ke.hu

B. Béri[2]
email: beri@agr.unideb.hu

Á. Süli[3]
email: suli@mgk.u-szeged.hu

É. Varga-Visi[1]
email: vargane.eva@ke.hu

Cs. Albert[4]
email:
albertcsilla@sapientia.siculorum.ro

Zs. Csapó-Kiss[1]
email: csapo.janosne@ke.hu

[1]Kaposvár University,
Faculty of Animal Science,
H-7400 Kaposvár, Guba S. u. 40.

[2]Debrecen University,
Centre for Agricultural and Applied Economic Sciences,
H-4032 Debrecen, Böszörményi út 138.

[3]University of Szeged,
Faculty of Agriculture,
H-6800 Hódmezővásárhely, Andrássy u. 15.

[4]Sapientia-Hungarian University of Transylvania,
Csíkszeredai Campus, RO-530104, Libertatii 1., Miercurea-Ciuc

Key words and phrases: amino acid, protein content, colostrum, dairy cow.

Abstract. The dry matter, crude protein, and amino acid content of colostrum and milk of different dairy cow breeds that were kept under the same conditions were determined. There were not notable differences between breeds regarding the dry matter, crude protein, and amino acid content of colostrum samples obtained on the first, third, and fifth days of lactation. The single exception was the third-day-colostrum from Holstein-Friesian that contained more of these compounds than the other breeds. The amino acid composition of protein from the colostrum of breeds under investigation was also very similar.

The milk samples of Jersey and Swedish red contained the highest amount of dry matter, crude protein, and that of amino acids in the examined lactation period (3-5 months after calving). The ratios of the individual essential amino acids within milk protein did not differ notably among breeds. Based on the Morup-Olesen biological value calculation, among the studied breeds, the amino acid composition of milk proteins from Holstein-Friesian was the most similar to the reference protein in the average of the 3-5 months of lactation.

1 Introduction

Colostrum is a transitional feed of the cow from the blood to the milk; therefore, its composition is similar to that of the blood. Its dry matter, crude protein, and mineral content are higher than that of the milk, but its lactose content is lower. The rapid change in the concentration of the given compounds is the most spectacular immediately after calving, the variability of compounds decreases from the third-fourth days of lactation. There are several other parameters affecting the composition of colostrum, e.g. breed, feeding, age (number of lactations), and health status (*Csapó*, 1984).

Contrary to colostrum, the composition of normal milk and the factors affecting it have been thoroughly studied. The dry matter and protein content of milk depends mostly on breed, lactation status, and age. Seasonal changes are associated with feeding (*Brunner*, 1976; *Cerbulis* and *Farrel*, 1974; *Csapó* and *Csapó-Kiss*, 1998).

Holstein-Friesian has become the dominating dairy cow breed in the most part of the world. The degree of utilization of the other breeds partially depends on their milk composition and their secondary properties. The main aim of our investigation was to compare the amino acid content and the amino acid composition of colostrum and milk of Holstein-Friesian and other dairy cow breeds kept under the same conditions.

2 Materials and methods

2.1 Milk sampling

Colostrum and milk samples originated from the "Kőrös-Maros Biofarm" Ltd. from Gyulavári, Hungary. There are about 500 Holstein-Friesian cows in this plant. Individuals of further breeds were imported (Swedish red, Jersey, Brown Swiss, Norwegian red, Ayshire) and an experiment was conducted in order to compare their production. Experimental animals were loose-housed cows kept in small groups. The bedding of the cow-shed was deep litter and the house was provided with concreted open yard. The number of animals was 13-15 per part of the cow-shed. Feed and water were provided in the open yard. The level of the water was fixed in the drinking trough and the feed was prepared with mixer-feeder wagon. Milking was obtained twice a day with herringbone milking parlour.

Feed met the requirements of bioproduction. The daily intake was 9 kg corn silage, 4 kg alfalfa silage, 2 kg alfalfa hay, 9 kg triticale haylage. The amount of the provided concentrate (6-9 kg) depended on the milk production. The individual dry matter consumption was 19.1 kg, the milk production net energy 125 MJ, and the metabolizable protein content 2,017 g.

Colostrum samples were taken on the first, third, and fifth days after calving. Three individuals from each breed were milked and the lactations of the same animals were followed.

The milk samples originated from three milking sessions of the trial flock. Milk samples originated from cows with similar days of lactation were sorted out (Table 1) and analysed.

Table 1: The average lactation time of the milked cows

Breed	**Days of lactation, average** ($n = 3$)		
	1st milking	**2nd milking**	**3rd milking**
Swedish red	99	118	157
Jersey	94	112	151
Holstein-Friesian	91	122	151
Brown Swiss	104	124	160
Norwegian red	89	110	149

2.2 Chemical analysis

Chemical analysis was carried out at the Department of Chemistry-Biochemistry, Faculty of Animal Science, Kaposvár University. The determination of dry matter content was based on the Hungarian standard MSZ 3744-81. The crude protein content was measured with a Kjeltec 2400 type automatic crude protein analyser and the related international standard (MSZ EN ISO 5983-2) was applied.

The amino acid content was quantified following acidic hydrolysis (6M hydrochloric acid solution, 110°C, 24 h) with an AAA 400 type amino acid analyser (Ingos).

The biological value was calculated on the basis of the Morup-Olesen index.

$$\text{Biological score} = 10^{2,15} \cdot q_{\text{Lys}}^{0,41} \cdot q_{\text{arom}}^{0,60} \cdot q_{\text{sulf}}^{0,77} \cdot q_{\text{Thr}}^{2,41} \cdot q_{\text{Trp}}^{0,41}$$

$q = a/a_{\text{ref}}$,
a = the ratio of the given essential amino acid/the ratio of the total essential amino acids in the sample protein,
a_{ref} = the ratio of the given essential amino acid/the ratio of the total essential amino acids in the reference protein,
arom = the sum of the ratio of aromatic amino acids (Tyr+Phe),
sulf = the sum of the ratio of sulfur containing amino acids (Cys+Met).

The reference protein was the 66:43 (w/w%) mixture of potato and egg because the highest nitrogen retention was observed at this ratio (*Morup and Olesen*, 1976).

3 Results

3.1 Colostrum

The dry matter content of the colostrum samples and the results of the crude protein content determination can be seen in Table 2. There was not any difference among breeds regarding these parameters in samples milked on the first and fifth days. The third-day-colostrum from Holstein-Friesians contained more dry matter and crude protein than that of the other breeds.

The dry matter and also the crude protein content of samples decreased significantly between the first and the third days. In the next time period (between the third and fifth days), there was no spectacular difference in the above-mentioned parameters with the exception of the colostrum of Holstein-Friesian and Ayrshire cows.

Table 2: The amount of some basic constituents of the colostrum of different dairy cow breeds

Days of lactation	Dry matter content (%)					
	Swedish red	Jersey	Holstein-Friesian	Brown Swiss	Norwegian red	Ayrshire
1	28.50	31.13	31.67	31.43	30.07	32.67
3	14.70	15.60	22.37	15.03	15.07	17.40
5	16.67	16.20	16.93	15.40	15.63	15.60

Days of lactation	Crude protein content % (N% × 6.38)					
	Swedish red	Jersey	Holstein-Friesian	Brown Swiss	Norwegian red	Ayrshire
1	17.31	19.16	19.75	17.66	18.71	19.50
3	5.97	6.59	11.57	5.23	4.59	8.26
5	4.95	5.80	5.04	4.51	4.75	5.36

The amino acid content of the colostra (Table 3) did not differ significantly by breeds on the first and the fifth days of lactation. However, there was some variation between the breeds on the third day. The colostrum of Holstein-Friesian cows contained more lysine, methionine, threonine, phenylalanine, valine, and isoleucine than that of the other breeds on the same day. There was a high decrease in the amino acid content between the first and the third days, following a moderate decrease or stagnation between days 3 and 5.

There were no spectacular differences in the amino acid composition of the colostrum proteins among the breeds. On the third and the fifth days, the colostrum proteins of Norwegian red and Brown Swiss contained a little more lysine and less threonine than that of the other breeds. Regarding the essential amino acids, the ratio of threonine showed the highest variation among breeds while the ratio of the other amino acids (phenylalanine, valine isoleucine, and leucine) was practically the same for the examined breeds.

In the function of lactation time, the composition of the colostrum proteins did not seem to differ notably between the first and the fifth days in the case of the most essential amino acids: the ratio of lysine, methionine, leucine, phenylalanine, and valine practically did not change. The ratio of threonine showed a decreasing tendency within the protein content. The ratio of non-essential glutamic acid and proline increased with time, similarly to the way it had been observed previously (*Csapó*, 1984).

Table 3: The essential and semi-essential amino acid content of colostrums originated from different cattle breeds (g amino acid/100 g sample)[1]

Amino acids	Day	Swedish red		Jersey		Holstein-Friesian		Brown Swiss		Norwegian red		Ayrshire	
		Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
Thr	1st	1.047	0.093	1.263	0.270	1.237	0.071	1.100	0.030	1.143	0.249	1.160	0.044
	2nd	0.297	0.040	0.323	0.133	0.667	0.265	0.230	0.030	0.190	0.044	0.437	0.143
	3rd	0.207	0.035	0.290	0.096	0.230	0.070	0.173	0.021	0.190	0.046	0.230	0.062
Cys	1st	0.253	0.031	0.310	0.080	0.300	0.044	0.253	0.012	0.267	0.067	0.283	0.029
	2nd	0.077	0.015	0.080	0.053	0.180	0.062	0.050	0.010	0.037	0.012	0.110	0.035
	3rd	0.040	0.010	0.063	0.025	0.053	0.032	0.027	0.006	0.037	0.012	0.050	0.020
Val	1st	1.173	0.065	1.347	0.241	1.373	0.061	1.210	0.072	1.193	0.097	1.340	0.010
	2nd	0.360	0.040	0.393	0.137	0.757	0.248	0.307	0.035	0.263	0.051	0.527	0.150
	3rd	0.283	0.040	0.350	0.101	0.300	0.072	0.257	0.023	0.277	0.060	0.317	0.050
Met	1st	0.383	0.006	0.387	0.051	0.403	0.040	0.383	0.040	0.430	0.044	0.423	0.049
	2nd	0.140	0.010	0.157	0.050	0.247	0.067	0.127	0.006	0.117	0.021	0.187	0.055
	3rd	0.123	0.012	0.133	0.031	0.123	0.015	0.120	0.010	0.123	0.025	0.137	0.012
Ile	1st	0.663	0.015	0.690	0.098	0.730	0.092	0.677	0.064	0.727	0.067	0.747	0.055
	2nd	0.257	0.025	0.283	0.091	0.453	0.107	0.233	0.015	0.203	0.042	0.330	0.082
	3rd	0.223	0.021	0.247	0.065	0.227	0.040	0.210	0.017	0.217	0.045	0.237	0.021
Leu	1st	1.457	0.050	1.570	0.262	1.640	0.132	1.473	0.110	1.590	0.144	1.703	0.076
	2nd	0.507	0.051	0.557	0.181	0.953	0.261	0.443	0.035	0.400	0.079	0.717	0.180
	3rd	0.427	0.049	0.490	0.121	0.430	0.092	0.390	0.026	0.423	0.085	0.477	0.057
Tyr	1st	0.823	0.031	0.907	0.144	0.970	0.069	0.883	0.058	0.907	0.083	0.933	0.029
	2nd	0.277	0.025	0.307	0.116	0.557	0.159	0.247	0.025	0.210	0.044	0.393	0.106
	3rd	0.227	0.032	0.270	0.075	0.243	0.051	0.213	0.012	0.223	0.055	0.247	0.031
Phe	1st	0.723	0.025	0.777	0.127	0.817	0.076	0.730	0.052	0.777	0.065	0.813	0.040
	2nd	0.253	0.021	0.277	0.096	0.480	0.123	0.223	0.015	0.200	0.036	0.350	0.085
	3rd	0.213	0.021	0.250	0.066	0.217	0.040	0.197	0.015	0.210	0.046	0.233	0.025
Lys	1st	1.217	0.038	1.327	0.216	1.387	0.090	1.253	0.102	1.350	0.101	1.420	0.060
	2nd	0.443	0.047	0.477	0.156	0.833	0.227	0.403	0.031	0.357	0.074	0.620	0.160
	3rd	0.373	0.055	0.423	0.106	0.380	0.082	0.353	0.031	0.377	0.080	0.410	0.046

[1]n=3 for each time and breed

Having the protein fractions of colostrum analysed, it can be stated that the casein content already reached a stabile level after the third day while in the case of whey protein, there were some differences between values obtained on the third and the fifth days. The amount of non-protein nitrogen (NPN) decreased continuously during the observed time period.

3.2 Milk

The dry matter and protein content of the milk of the different breeds can be seen in Table 4. The concentrated milk breeds showed higher values in the case of these parameters. In the investigated time period (3-5 months), there are not any distinct tendencies regarding dry matter or crude protein content. This observation is contrary to the results of a previous investigation when an increase of these parameters from the second months of lactation was detected (*Csapó*, 1984).

Table 4: The amount of some basic constituents of the milk of different dairy cow breeds

Months of lactation	**Dry matter content** (%)					
	Swedish red	Jersey	Holstein-Friesian	Brown Swiss	Norwegian red	Ayrshire
3	12.00	14.06	13.18	13.28	12.07	12.02
4	12.83	16.29	13.71	12.98	12.40	12.65
5	12.48	15.12	13.74	12.29	13.28	12.88

Months of lactation	**Crude protein content %** (N% × 6.38)					
	Swedish red	Jersey	Holstein-Friesian	Brown Swiss	Norwegian red	Ayrshire
3	3.81	4.45	3.48	3.27	3.34	3.16
4	3.89	4.29	3.36	3.67	3.56	3.00
5	3.88	4.19	3.59	3.46	3.49	3.45

In the case of a given breed, the amino acid content of its milk did not seem to change in the function of time in the examined period, similarly to the protein content. In this experiment, the three-month - period was presumably too short to detect any changes if there were any. Analysing the differences between breeds regarding the amino acid content of their milk, it can be clearly seen that the amount of the essential amino acids (Table 5) is proportional to the protein content.

Table 5: The essential and semi-essential amino acid content of milks originated from different cattle breeds (g amino acid/100 g sample)[1]

Amino acid	Swedish red		Jersey		Holstein-Friesian		Brown Swiss		Norwegian red		Ayrshire	
	Mean	Std deviation	Mean	Std deviation	Mean	Std deviation	Mean	Std deviation	Mean	Std deviation	Mean	Std deviation
Thr	0.159	0.002	0.178	0.008	0.143	0.008	0.144	0.011	0.142	0.003	0.130	0.008
Cys	0.028	0.002	0.029	0.001	0.023	0.003	0.019	0.002	0.018	0.001	0.014	0.001
Val	0.218	0.003	0.237	0.011	0.214	0.009	0.216	0.016	0.213	0.006	0.195	0.004
Met	0.096	0.001	0.105	0.004	0.083	0.001	0.083	0.005	0.082	0.003	0.079	0.005
Ile	0.189	0.002	0.211	0.008	0.160	0.003	0.166	0.013	0.160	0.005	0.148	0.007
Leu	0.358	0.003	0.390	0.013	0.309	0.009	0.308	0.021	0.306	0.008	0.285	0.016
Tyr	0.179	0.001	0.201	0.009	0.151	0.006	0.154	0.010	0.151	0.004	0.140	0.006
Phe	0.177	0.002	0.196	0.007	0.153	0.006	0.155	0.011	0.152	0.006	0.143	0.008
Lys	0.312	0.002	0.345	0.011	0.258	0.011	0.261	0.017	0.262	0.008	0.242	0.014

[1]Average values of three milking sessions on the 3rd, 4th, and 5th month of lactation

The higher protein content in the case of Jersey and Swedish red was accompanied with higher essential amino acid concentration of their milk. The amino acid composition of milk protein showed only slight changes in the function of time. The amino acid pattern of the milk proteins also did not differ notably by breeds. The results of previous examinations led to the same conclusion regarding milk proteins of Jersey and Holstein-Friesian cows (*Csapó*, 1984).

When the biological value (Table 6) is calculated on the basis of the Morup-Olesen index, the deviation *in both directions* from the amino acid pattern of the reference protein lowers the score. Moreover, the small variance between the amino acid compositions of milk proteins of different breeds is magnified. Therefore, higher differences were detected in the biological value of milk protein originated from different breeds than that of the ratios of the individual amino acids.

Table 6: The biological value of milks originated from different cattle breeds[1]

	Swedish red	Jersey	Holstein-Friesian	Brown Swiss	Norwegian red	Ayrshire
Biological value	69	66	77	75	73	70

[1]Average values of three milking sessions on the 3rd, 4th, and 5th month of lactation

The biological value of the milk in the average of 3-5 months of lactation was 69 for Swedish red, 66 for Jersey, 77 for Holstein-Friesian, 75 for Brown Swiss, 73 for Norwegian red, and 70 for Ayrshire. All of the examined proteins contained higher ratio of lysine and aromatic amino acids (tyrosine and phenylalanine) than that of the reference protein, but the ratio of threonine and sulfur containing amino acids (cysteine + methionine) was lower. The essential amino acid composition of milk protein of Holstein-Friesian was the closest to the reference protein.

4 Summary

To summarize, it can be concluded that the dry matter, crude protein, and amino acid content of colostrums from the different breeds were similar. The only exception was the Holstein-Friesian, giving higher essential amino acid content colostrum on the third day. The colostrum from this breed also con-

tained more whey protein while the amount of casein was only a little less than that of the other breeds. Owing to the higher essential amino acid content of whey proteins, the colostrum of Holstein-Friesian was a more abundant source of these amino acids than that of the other breeds.

The crude protein content drop was different by breeds in the function of time. In most of the cases, low values were observed on the third day while in some cases, protein-fractions (e.g. whey protein, NPN) did not reach the levels of normal milk during this period.

Most of the essential amino acids changed proportionally to the crude protein content. The sum of the essential amino acids within colostrum protein decreased in the function of time. The essential amino acid content of milk was proportional to the crude protein content. Breeds having milk rich in protein gave milk with higher essential amino acid content because the amino acid composition of milk proteins was very similar.

5 Acknowledgements

This research has been accomplished with the financial support of the Jedlik Ányos Project. NKFP-07-A3 TEJUT-08.

References

[1] J. R. Brunner, Characteristics of edible fluids of animal origin: Milk. New York. John Wiley and Sons. Inc. (1976) 619–655.

[2] J. Cerbulis, H. M. Farrel, Composition of milk of dairy cattle. I. Protein, lactose and fat contents and distribution of protein fraction, *J. Dairy Sci.*, 58 (1974) 6.

[3] J. Csapó, Kolosztrum és a tej összetétele eltérő genotípusú szarvasmarháknál. (The composition of colostrum and milk in different cow breeds.) Dissertation for 'candidate of sciences' degree, University of Kaposvár, Hungary (1984) 119.

[4] J. Csapó, Zs. Csapó-Kiss, Biological value and change of milk protein in cattle, goats and sheep during lactation, *Acta Alimentaria*, 4 (1988) 372.

[5] K. Morup, E. S. Olesen, New method for prediction of protein value from essential amino acid pattern. *Nutrition Reports International*, 13. (1976) 355–365.

Generally the protein content of the milk reflects the growth rate of the young animal â€“ the higher the growth rate, the more protein the milk contains. There can be considerable compositional difference between breeds of a single species â€“ Jersey and Guernsey milks, for instance, are noted for their higher fat content which is reflected in a richer, creamier taste. Even within a single breed variations in composition can arise depending on factors such as the stage of lactation, the stage of milking, the intervals between milking, the time of day, the number of previous lactations and the general nutritional state and health of the cow. A more detailed analysis of cowâ€™s milk is presented in Table 5.2. The lipid content is the most variable feature. The composition and physicochemical properties of colostrum in black-and-white polish holstein-friesian cows, montbÃ©liarde cows and their crossbreeds. @inproceedings{Wojtas2016THECA, title={THE COMPOSITION AND PHYSICOCHEMICAL PROPERTIES OF COLOSTRUM IN BLACK-AND-WHITE POLISH HOLSTEIN-FRIESIAN COWS, MONTB{\'E}LIARDE COWS AND THEIR CROSSBREEDS}, author={Edyta Wojtas and A. Zachwieja}, year={2016} }. Edyta Wojtas, A. Zachwieja. Published 2016. Biology.Â Colostrum and milk of current and rare cattle breeds: protein content and amino acid composition. Expressing recombinant proteins in dairy animals to alter their milk composition is considered beneficial for human health. However, relatively little is known about the expression profile of the proteins in milk derived from transgenic cloned animals. In this study, we compared the proteome and nutrient composition of the colostrum andÂ Whether the protein profiles of milk from transgenic cloned cattle are altered by the cloning technology or by the expression of exogenous human genes in bovine mammary epithelial cells, and the mechanism by which such changes might occur, is unknown. Technological advances in proteomics have allowed an increased understanding and characterization of milk proteins. The amino acid content of colostrum differed on the third day of lactation. Holstein-Friesian cows contained more lysine, isoleucine, leucine, valine, phenylalanine, and threonine than that of Swedish red, Jersey, Brown Swiss and Norwegian red cows ($P < 0.05$). The decrease of the amino acid content in the function of time followed the decline of protein content. The composition of colostrum proteins showed some changes in terms of the increase of the ratio of the nonessential glutamic acid and proline, and decrease of the ratio of threonine.Â The amino acid composition of milk proteins of dif-ferent breeds only slightly differed, therefore the amino acid content of their milk reflected to the protein content. 5 ACKNOWLEDGEMENTS.