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COLOSTRUM AND MILK OF DIFFERENT CATTLE BREEDS AS AMINO ACID SOURCE

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ABSTRACT

The aim of the research was to compare the amino acid composition of colostrum and milk of the most current dairy cattle breed (Holstein-Friesian) and that of other breeds that occur less frequently. Breeds were kept at the same farm, other factors affecting colostrum and milk composition such as housing system and feed regime were kept at the same level. Amino acid analysis was carried out following acidic hydrolysis of proteins with an amino acid analyser with post-column derivatization. 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. The amino acid composition of milk proteins of the examined breeds differed only slightly. The higher protein content of the milk of concentrated-milk-breeds was accompanied with higher essential amino acid content.

Key words: cattle / colostrum / milk /amino acid content

1 INTRODUCTION

Colostrum is an indispensable source of nutrients for suckling calves while milk and milk products have got a prominent role in the animal protein supply of human beings. Holstein-Friesian is the highest production dairy animal and the most important dairy cow breed in great part of the world. Other breeds that are not so current can also have valuable features. They produce less milk, but their products may be valuable. Milk with a higher nutritional value is a good raw material for unique products such as functional foods, among them probiotic products.

One can compare the products of different breeds if other conditions having an influence on the milk compositions are maintained at the same level. Besides breed there are several other traits affecting the amino acid content of milk, such as lactation status and age. As the composition of different protein fractions is genetically coded, the amino acid content of milk protein depends on the ratio of the protein fractions (Brunner, 1976; Cerbulis and Farrel, 1974; Csapó and Csapó-Kiss, 1988).

The amino acid content of colostrum is rapidly changing in the first few days after calving therefore the sampling of different breeds should be accomplished at the same time after parturition. In addition, feeding, the number of lactations and health status can also effect the composition of colostrum (Csapó, 1984).

The aim of the present research was to compare Holstein-Friesian and other dairy and dual purpose breeds in relationship with the amino acid content of their colostrum and milk under the same housing system and feeding regime.

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2 MATERIAL AND METHODS

The samples of milk and colostrum were obtained from a farm having approximately 500 Holstein-Friesian cows (Kőrös-Maros Biofarm Ltd., Gyulavári, Hungary). Besides this commercial breed other species were also included for experimental purposes. Swedish red, Jersey, Brown Swiss, Norwegian red, Ayshire and Holstein-Friesian individuals were loose-housed cows kept in small groups. Milking with herringbone milking parlour was carried out twice a day. The feed of the cows contained 9 kg corn silage, 4 kg alfafa silage, 2 kg alfafa hay, 9 kg triticale haylage. The amount of the concentrate provided (6–9 kg) was set according to the milk production. The individual dry matter consumption was 19.1 kg, the milk production net energy 125 MJ and the metabolisable protein content 2017 g.

The samples of colostrum were collected on the first, third and fifth days after calving. The number of repetition was three for each breed.

Normal milk samples were drawn from three milking of the trial flock. The average lactation days of cows on the first milking ranged from 88 to 104 days. That of the second and the third milking were from 110 to124 and from 149 to 157, respectively.

Chemical composition was analysed in the laboratory of the Department of Chemistry-Biochemistry, Faculty of Animal Science, Kaposvár University. 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).

Statistical analyses were performed using IBM SPSS Statistic, Version 19. The effect of breed and time after calving on the composition of milk and colostrum was analysed with multiple analysis of variance (GLM procedure of SPSS). The null hypothesis was rejected if $P < 0.05$. In the case of the rejection of the null hypothesis Student-Newman-Keuls post hoc test was applied for the comparison of means. In order to analyze the differences between breeds within the same sampling time one-way analysis of variance (ANOVA procedure of SPSS) was applied for amino acid composition and amino acid content of colostrum.

3 RESULTS AND DISCUSSION

The amino acid content of colostrum did not differ by breeds at the beginning of sampling (1st day, $P \geq 0.05$). Similar was observed for samples collected at the last occasion of sampling (5th day). However, in the middle (3rd day), there were significant differences. On this day the colostrum of Holstein-Friesian cows contained more lysine, isoleucine, leucine, valine, phenylalanine, and threonine than that of Swedish red, Jersey, Brown Swiss and Norwegian red cows ($P < 0.05$). Ayshire breed neither differed from Holstein-Friesian nor from the group with lower amino acid content.

As the protein content of colostrum decreased in function of time, the same tendency was observed in the case of the individual amino acids. The quantity of each amino acid showed a significant decrease from the first to the fifth day ($P < 0.05$). Nevertheless, the highest drop was observed between the 1st and the 3rd days. The amount of each amino acid decreased from the third to the fifth day, but this change was more moderate than between the first and the third days.

The effect of breeds on the composition of colostrum protein was analysed first on the same day. On the first day only the leucine, valine and tyrosine content differed among breeds (Table 1.) while on the fifth day there were significant differences in threonine, leucine, aspartic acid and lysine content. However, there was a transitional deviation on the third day in the amount of serine, glutamic acid, glycine, cysteine, methionine, isoleucine among breeds.

The proteins of foremilk of Norwegian red and Brown Swiss contained more lysine than that of Jersey, Holstein-Friesian and Swedish red and less threonine than that of Holstein-Friesian and Jersey ($P < 0.05$) when multiple analysis of variance was applied and day and breed were regarded as factors. The greater extent of variation was observed in the case of threonine among the essential amino acids.

The proteins of colostrum drown on the fifth day of lactation contained more non-essential amino acids e.g. glutamic acid and proline than that of samples obtained immediately after calving ($P < 0.05$). Similar tendency was observed previously for the foremilk of Jersey and Holstein-Friesian cows (Csapó, 1984). In the case of essential amino acids a distinct decrease was measured for threonine in the function of time. The ratio of valine also dropped, while that of metionine, isoleucine, leucine, phenylalanine and lysine slightly but significantly increased.

The amount of the three protein fractions of colostrum was also measured during this period (Table 2.). There were not detected significant differences among breeds and means of the different sampling days did not differ either ($P > 0.05$). The variation of whey proteins' content was higher than that of casein and NPN content.

The amount of individual amino acids in normal milk samples of different breeds did not vary notably in the function of time. Maybe the examined period (from the third to the fifth month) was too short to see any important changes. Analysing the results on breeds showed

Table 1: *The amino acid composition of colostral proteins of different cattle breeds on the first and the fifth day of lactation (g amino acid/100 g protein)* [1, 2]

	Breed																	
	Swedish red			Jersey			Holstein- Friesian			Brown Swiss			Norwegian red			Ayrshire		
Amino acid	1st day	3rd day	5th day	1st day	3rd day	5th day	1st day	3rd day	5th day	1st day	3rd day	5th day	1st day	3rd day	5th day	1st day	3rd day	5th day
Asp	7.9	7.7	7.5^{ab}	8.0	7.4	7.7^{b}	7.9	7.8	7.5^{ab}	7.8	7.4	7.2^{a}	8.1	7.4	7.4^{ab}	7.9	7.9	7.4^{ab}
Thr	6.1	5.1^{ab}	4.3^{ab}	6.6	5.0^{ab}	5.1^{b}	6.3	5.7^{b}	4.6^{ab}	6.3	4.5^{a}	3.9^{a}	6.1	4.3^{a}	4.1^{ab}	6.0	5.3^{ab}	4.3^{ab}
Ser	7.7	6.2^{ab}	5.7	8.3	6.2^{ab}	6.2	7.9	7.2^{b}	6.0	7.6	5.9^{a}	5.6	7.4	5.5^{a}	5.5	7.5	6.6^{ab}	5.8
Glu	16.5	19.0^{abc}	20.3	15.5	19.0^{abc}	19.0	15.4	16.8^{a}	19.3	15.8	19.4^{bc}	20.3	16.5	19.7^{b}	20.0	16.1	17.2^{ab}	19.3
Pro	8.7	9.3	9.6	8.7	9.7	9.6	8.9	9.1	9.3	8.7	9.6	9.9	8.5	9.6	9.5	8.8	8.8	9.6
Gly	2.9	2.3^{ab}	2.0	3.2	2.3^{ab}	2.3	3.2	2.8^{b}	2.3	3.1	2.3^{ab}	2.0	3.0	2.1^{a}	2.0	3.0	2.8^{ab}	2.2
Ala	3.6	3.3	3.2	3.7	3.4	3.4	3.7	3.6	3.4	3.7	3.3	3.3	3.7	3.3	3.4	3.7	3.7	3.4
Cys	1.5	1.0^{ab}	0.8	1.6	1.2^{ab}	1.1	1.5	1.5^{b}	1.0	1.4	1.0^{ab}	0.6	1.4	0.8^{a}	0.8	1.5	1.4^{ab}	1.0
Val	6.8^{b}	6.2^{abc}	5.9	7.0^{b}	6.1^{ab}	6.1	7.0^{b}	6.6^{c}	6.0	6.9^{b}	6.0^{a}	5.8	6.4^{a}	6.0^{a}	5.9	6.9^{b}	6.5^{bc}	6.1
Met	2.2	2.4^{ab}	2.6	2.0	2.5^{ab}	2.4	2.1	2.2^{a}	2.5	2.2	2.5^{ab}	2.7	2.3	2.7^{b}	2.6	2.2	2.3^{a}	2.8
Ile	3.8	4.4^{ab}	4.7	3.6	4.4^{ab}	4.4	3.7	4.0^{a}	4.6	3.9	4.6^{b}	4.8	3.9	4.6^{b}	4.6	3.8	4.1^{a}	4.5
Leu	8.4^{ab}	8.7^{ab}	8.9^{ab}	8.2^{a}	8.7^{ab}	8.7^{a}	8.4^{ab}	8.4^{a}	8.7^{a}	8.4^{ab}	8.7^{ab}	8.9^{ab}	8.6^{ab}	9.0^{b}	9.1^{b}	8.8^{b}	8.8^{b}	9.1^{b}
Tyr	4.8^{a}	4.7	4.7	4.8^{a}	4.7	4.7	5.0^{b}	4.9	4.9	5.0^{b}	4.8	4.8	4.9^{ab}	4.7^{b}	4.8	4.8^{a}	4.8^{b}	4.7
Phe	4.2	4.3	4.4	4.1	4.3	4.4	4.2	4.3	4.4	4.2	4.4	4.5	4.2	4.5	4.5	4.2	4.3	4.5
His	2.3	2.4	2.4	2.1	2.4	2.4	2.3	2.3	2.5	2.3	2.5	2.5	2.3	2.5	2.4	2.3	2.4	2.5
Lys	7.1	7.6^{a}	7.8^{ab}	7.0	7.4^{a}	7.5^{a}	7.1	7.3^{a}	7.6^{a}	7.1	8.0^{b}	8.0^{bc}	7.3	8.0^{b}	8.1^{c}	7.3	7.6^{a}	7.8^{abc}
NH_3	1.6	1.8	1.8	1.6	1.8	1.8	1.6	1.7	1.9	1.7	1.8	2.0	1.6	1.9	1.9	1.6	1.7	1.9
Arg	3.9	3.4	3.4	3.9	3.6	3.6	3.8	3.5	3.5	3.7	3.3	3.3	3.7	3.3	3.3	3.6	3.2	3.2

[1] n = 3 for each time and breed; [2] Means of breeds on the same day lacking a common superscript differ ($P < 0.05$)

Table 2: *The non-protein-nitrogen (NPN), casein and whey protein content of the colostrum from different cattle breeds (g/100 g colostrum sample)* [1]

	NPN			Casein			Whey proteins		
Breed	1st day	3rd day	5th day	1st day	3rd day	5th day	1st day	3rd day	5th day
Swedish red	0.35	0.31	0.29	4.4	4.2	4.3	4.2	4.7	5.5
Jersey	0.25	0.32	0.24	3.6	4.8	4.1	6.8	7.2	4.4
Holstein-Friesian	0.45	0.48	0.35	4.1	4.0	4.3	8.1	8.7	5.9
Brown Swiss	0.31	0.32	0.36	4.7	4.0	4.2	4.8	4.2	4.5
Norwegian red	0.29	0.36	0.37	4.7	4.4	4.4	4.3	4.3	4.9
Ayrshire	0.35	0.36	0.32	4.6	4.7	4.6	6.8	6.1	5.3

[1] n = 3 for each time and breed

that the higher protein content of the milk of breeds with concentrated milk was accompanied with higher essential amino acids' content.

The amino acid composition of milk proteins of different breeds was similar. Small, but significant differences were detected in the case of glutamic acid, proline, glycine, alanine, cystine, valine, isoleucine, leucine, tyrosine, phenylalanine, lysine and arginine (Table 3.). Moreover, the amino acid pattern was not influenced by the elapsed days of lactation between the third and the fifth month. Previous studies with Jersey and Holstein-Friesian breeds led to similar results (Csapó, 1984).

4 CONCLUSIONS

The amino acid content of the colostrum of the examined breeds was very similar in the experimental period with the exception of a transition state on the third day.

The proteins of the foremilk seemed to have more valuable amino acid composition after calving than on the fifth day of lactation as the ratio of nonessential amino acids present in high amount in the protein increases in the function of time. However, decreasing tendency was not observed for all of the essential amino acids.

Table 3: *The amino acid composition of milk protein of different breeds (g amino acid/100 g protein)* [1, 2]

	Breed					
Amino acid	Swedish red	Jersey	Holstein- Friesian	Brown Swiss	Norwegian red	Ayrshire
Asp	7.33	7.28	7.27	7.17	7.33	7.83
Thr	4.17	4.23	4.23	4.23	4.20	4.10
Ser	5.50	5.47	5.60	5.63	5.67	5.60
Glu	20.60^{ab}	20.50^{a}	20.73^{abc}	20.93^{bc}	21.10^{c}	21.13^{c}
Pro	9.33^{b}	9.40^{b}	8.93^{a}	9.28^{b}	8.83^{a}	8.90^{a}
Gly	1.73^{a}	1.80^{ab}	1.83^{ab}	1.90^{b}	1.83^{ab}	1.80^{ab}
Ala	3.13^{ab}	3.20^{b}	3.20^{b}	3.17^{b}	3.13^{ab}	3.03^{a}
Cys	0.73^{b}	0.67^{bc}	0.67^{bc}	0.53^{ab}	0.53^{ab}	0.43^{a}
Val	5.73^{a}	5.63^{a}	6.37^{b}	6.33^{b}	6.30^{b}	6.20^{b}
Met	2.50	2.50	2.47	2.43	2.40	2.53
Ile	4.93^{ab}	5.00^{b}	4.73^{a}	4.87^{ab}	4.73^{a}	4.73^{a}
Leu	9.36^{c}	9.23^{b}	9.13^{ab}	9.03^{a}	9.10^{ab}	9.10^{ab}
Tyr	4.67^{b}	4.80^{c}	4.50^{a}	4.53^{a}	4.50^{a}	4.43^{a}
Phe	4.60^{a}	4.70^{b}	4.57^{a}	4.53^{a}	4.53^{a}	4.58^{a}
His	2.50	2.50	2.50	2.40	2.43	2.48
Lys	8.20^{c}	8.20^{c}	7.63^{a}	7.63^{a}	7.80^{b}	7.70^{ab}
Arg	3.67^{c}	3.77^{c}	3.50^{b}	3.37^{ab}	3.37^{ab}	3.30^{a}

[1] Average values of three milking on the 3rd, 4th and 5th month of lactation; [2] Means within a row lacking a common superscript differ ($P < 0.05$)

The amino acid composition of milk proteins of different breeds only slightly differed, therefore the amino acid content of their milk reflected to the protein content.

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