Change of amino acid profile in Charolais cows' colostrum and transient milk during the first week *post partum*

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ABSTRACT: In this study the change in amino acid profile in cow's colostrum and transient milk during the first week after parturition was examined in a Hungarian Charolais herd. Experiments were carried out with n = 37 Charolais cows in the same herd in the spring (March–April) of two consecutive years (Experiment 1: 2002, n = 15; and Experiment 2: 2003, n = 22). Colostrum and milk samples were taken by hand milking immediately after delivery, and in 24, 48, 72, and 168 hours *post partum*. Amino acid contents (%) in samples were measured in milk protein with an automatic amino acid analyser. Data were processed by the software of SPSS.10 statistical program package. In the postpartal period, among essential amino acids significant increases were recorded in methionine, isoleucine, lysine, and phenylalanine, and among non-essential amino acids glutamic acid and proline increased significantly. Simultaneous decreases were recorded in valine, cysteine, aspartic acid, serine, glycine, and arginine. Inconsistent figures were determined for histidine, leucine, tyrosine, and alanine content between Experiment 1 and Experiment 2.

Keywords: Charolais cows; colostrum; transient milk; amino acids

In beef cattle, good mothering ability is of crucial interest. In this trait of economic importance cow's milk yield is a coherent factor. Colostrum and transient milk – being the only feeds of the calf in the first week of life – are important not only for the development of passive immunity but also for ensuring sufficient amounts of carbohydrates, lipids, proteins, minerals, and vitamins (Blum and Hammon, 2000). In ruminants, rumen microorganisms are able to produce amino acids that are essential for non-ruminant species. At this age, however, the rumen functions have not been developed yet. Thus, threonine, valine, methionine, isoleucine, leucine, phenylalanine, lysine and histidine are essential for them as it is the case in monogastric animals (Riis, 1984). Solymos and Horn (1994) stated that the amino acid profile in colostrum consumed at the first sucking is similar to that of uterine milk (embryotroph), except methionine and glutamic acid. Calves are born without sufficient essential amino acid supply. No long-term effect of colostrum intake on blood plasma free amino acids was recorded by Zanker et al. (2000) when postponed by 24 hours, in spite of its long-term effect on either plasma IgG or protein content. The findings of Hammon and Blum (1999) confirmed a marked effect of colostrum intake on plasma free amino acid levels in new-born calves, especially on glutamine and glutamic acid.

Only little information is available on the colostrum amino acid profile of beef cows. Findings mostly refer to dairy cows, and there are no such data for Charolais cows at all. Arzumanjan and Timofejeva (1972) reported increasing histidine,

Table 1. Amino acid profile in the first milked colostrum of different beef breeds (Kovács, 1999)

Amino acid		Red Angus $n = 8$	Aberdeen Angus $n = 9$	Hungarian Simmental $n = 18$	Limousine $n = 12$	Blonde d'Aquitaine $n = 20$
Essential (%)	TRE	6.17 ± 0.80	6.27 ± 0.18	7.35 ± 0.48	7.30 ± 0.57	6.32 ± 0.60
	VAL	4.66 ± 0.56	4.72 ± 0.40	6.73 ± 0.27	6.67 ± 0.40	4.20 ± 0.43
	MET	2.41 ± 0.40	2.36 ± 0.39	1.98 ± 0.33	2.17 ± 0.36	2.16 ± 0.41
	ILE	2.96 ± 0.32	2.78 ± 0.34	3.42 ± 0.21	3.52 ± 0.26	2.42 ± 0.39
	LEU	8.31 ± 0.43	8.46 ± 0.29	8.72 ± 0.45	8.82 ± 0.29	8.21 ± 0.58
	PHE	4.07 ± 0.55	4.04 ± 0.22	4.01 ± 0.27	4.02 ± 0.41	3.53 ± 0.44
	LYS	6.84 ± 0.32	6.77 ± 0.48	6.62 ± 0.37	6.57 ± 0.43	7.15 ± 0.50
	HIS	2.27 ± 0.20	2.30 ± 0.21	2.18 ± 0.20	2.04 ± 0.16	2.22 ± 0.46
Semi-essential (%)	CYS	1.96 ± 0.30	1.79 ± 0.34	2.35 ± 0.41	2.35 ± 0.51	1.42 ± 0.37
	TYR	5.26 ± 0.23	5.22 ± 0.36	4.67 ± 0.31	4.59 ± 0.29	4.64 ± 0.52
Non-essential (%)	ASP	8.82 ± 0.89	9.37 ± 0.44	7.95 ± 0.54	8.06 ± 0.48	9.16 ± 0.55
	SER	9.32 ± 1.32	9.47 ± 0.63	8.63 ± 1.35	8.63 ± 0.50	10.0 ± 0.80
	GLU	14.7 ± 1.68	14.8 ± 0.62	15.0 ± 0.62	15.1 ± 0.62	16.9 ± 1.08
	PRO	8.44 ± 1.32	8.04 ± 0.88	7.89 ± 0.88	8.06 ± 0.95	8.72 ± 0.67
	GLY	3.82 ± 0.36	3.93 ± 0.26	3.59 ± 0.24	3.53 ± 0.29	3.69 ± 0.27
	ALA	4.15 ± 0.33	4.29 ± 0.13	3.91 ± 0.17	3.94 ± 0.17	3.96 ± 0.27
	ARG	4.40 ± 0.30	4.24 ± 0.36	3.86 ± 0.33	3.88 ± 0.38	3.94 ± 0.47

lysine, glutamine, alanine, tyrosine, and leucine contents, and decreasing aspartic acid, serine, glycine, threonine, valine, and phenylalanine contents in the colostrum and milk of dairy cows in the first ten days after parturition. Davis et al. (1994) recorded increasing tendencies for glutamic acid, proline, methionine, isoleucine and lysine content, while cysteine, glycine, serine, threonine, and alanine decreased in colostrum and milk protein in the first week after calving. Szentpéteri et al. (1986) analysed the effects of criss-crossing using Jersey and Holstein Friesian breeds (Hungaro-Friesian: 50% Jersey + 25% Hungarian Simmental + 25% Holstein Friesian; and 62.5% Holstein Friesian + 25% Jersey + 12.5% Hungarian Simmental) on colostrum (for 4 days *post partum*), transient milk (days 4 to 10 after parturition), and normal milk components. Tendencies of amino acid contents in protein were similar for the two genotypes throughout the first 30 days after calving. Concentrations of aspartic acid, threonine, tryptophan, serine, glycine, alanine, cysteine, valine, tyrosine, and arginine decreased, while those of glutamic acid, proline, methionine, isoleucine, leucine, phenylalanine and lysine increased. Histidine content remained unchanged in this period. These results for phenylalanine, alanine, and tyrosine show opposite tendencies to those published by Arzumanjan and Timofejeva (1972). The total of essential amino acids decreased rapidly in the first 3 days *post partum*, later on (from day 10 to 25) the decrease tended to slow down at a reduced rate. There were no significant differences between the two genotypes in either essential or non-essential amino acid contents. In the first 5 days after calving Csapó (1992) found similar tendencies, as it was the case in the study of Szentpéteri et al. (1986)

In Hungary Kovács (1999) was the first to analyse the amino acid profile in the first colostrum samples of beef cows (Red Angus, Aberdeen Angus, Hungarian Simmental, Limousine, and Blonde d'Aquitaine, Table 1). The largest differences between breeds were observed in valine, threonine and isoleucine contents. However, differences were significant only between breeds kept on different farms, which draws the attention to environmental effects. Nutrition is one of the environmental factors that can affect the amino acid profile in milk. Serine, proline, and glycine contents in colostrum protein of beef cows were higher ($P < 0.01$) than those published in dairy cows by Csapó (1992), while isoleucine and histidine contents were lower ($P < 0.05$).

The aim of this study was to analyse the amino acid profile in colostrum and transient milk protein of Charolais cows in the first week after parturition.

MATERIAL AND METHODS

Experiments were carried out on a Hungarian Charolais farm in the spring (March–April) of 2002 (Exp. 1) and 2003 (Exp. 2). The cows were housed indoors in an open barn attached by an exercise yard, as they are usually kept out of the grazing season. Cows were fed alfalfa hay and maize silage.

In two experiments (Exp. 1: 2002; Exp. 2: 2003) colostrum and transient milk samples (200 ml) were taken from 15 (Exp. 1) and 22 (Exp. 2) Hungarian Charolais cows immediately after delivery, and also in 24, 48, 72, and 168th hours *post partum*. Cows were in their 1–4 lactation (with 5 primiparous in Exp. 1, and 7 in Exp. 2). Three hours prior to sampling calves were prevented to suck the mothers. Cows were hand-milked; no oxytocin injections were applied. The first drops of milk were not milked into the sample. Cows with signs of clinical mastitis were not milked. Samples were then analysed for the main components (fat, protein, dry matter, somatic cells) at Hungarian Livestock Performance Testing Stations Ltd. Samples with somatic cell counts indicating subclinical mastitis were not involved into further investigation. From each sample of healthy cows, approximately 150 ml was deep-frozen to −18°C within an hour. Amino acid analysis was carried out at the Kaposvár University, Faculty for Animal Science, Institute of Chemistry, using an automatic amino acid analyser for essential (threonine (TRE), valine (VAL), methionine (MET), isoleucine (ILE), leucine (LEU), phenylalanine (PHE), lysine (LYS), and histidine (HIS)), semi-essential (cysteine (CYS), tyrosine

Table 2. Amino acid profile in Charolais cows' colostrum and transient milk protein (Exp. 1, n = 15)

Amino acid		Mean ± standard deviation				
		time *post partum* (hours)				
		0	24	48	72	168
Essential (%)	TRE	6.53 ± 0.84^{ab}	5.05 ± 0.45^{ab}	4.52 ± 0.87^{ab}	3.94 ± 0.26^{a}	3.87 ± 0.30^{b}
	VAL	6.95 ± 0.48^{abcd}	6.72 ± 0.35^{a}	6.54 ± 0.31^{b}	6.49 ± 0.23^{c}	6.56 ± 0.29^{d}
	MET	1.47 ± 0.31^{ab}	2.06 ± 0.41^{ab}	2.41 ± 0.30^{a}	2.74 ± 0.47^{a}	2.59 ± 0.32^{b}
	ILE	3.10 ± 0.32^{abc}	3.81 ± 0.42^{abc}	4.26 ± 0.43^{a}	4.32 ± 0.27^{b}	4.33 ± 0.33^{c}
	LEU	8.15 ± 0.35^{acd}	8.63 ± 0.51^{a}	8.79 ± 0.41^{ce}	8.65 ± 0.65^{bd}	8.32 ± 0.47^{be}
	PHE	3.89 ± 0.25^{bc}	3.95 ± 0.28^{ad}	4.19 ± 0.31^{abc}	4.48 ± 0.28^{ab}	4.42 ± 0.30^{cd}
	LYS	6.80 ± 0.32^{abc}	7.50 ± 0.43^{abc}	7.75 ± 0.34^{a}	7.87 ± 0.26^{b}	7.72 ± 0.41^{c}
	HIS	2.43 ± 0.22	2.53 ± 0.26	2.41 ± 0.20	2.43 ± 0.21	2.40 ± 0.28
	Total	39.33 ± 0.93	40.24 ± 1.16	40.88 ± 1.39	40.93 ± 0.84	40.21 ± 1.03
Semi-essential (%)	CYS	2.28 ± 0.40^{ab}	1.67 ± 0.31^{ab}	1.08 ± 0.26^{ab}	0.80 ± 0.18^{a}	0.80 ± 0.20^{b}
	TYR	4.61±0.38^{b}	4.46 ± 0.30	4.40 ± 0.28^{ab}	4.65 ± 0.33^{a}	4.46 ± 0.25
	Total	6.89 ± 0.63	6.13 ± 0.21	5.48 ± 0.32	5.45 ± 0.34	5.26 ± 0.35
Non- essential (%)	ASP	8.41 ± 0.45^{ab}	7.82 ± 0.53^{ab}	7.36 ± 0.50^{ab}	7.04 ± 0.33^{a}	7.01 ± 0.41^{b}
	SER	8.00 ± 0.55^{ab}	6.60 ± 0.61^{ab}	5.82 ± 0.66^{ab}	4.83 ± 0.36^{a}	4.77 ± 0.42^{b}
	GLU	16.98 ± 1.19^{a}	19.89 ± 1.18^{a}	21.49 ± 0.90^{a}	22.17 ± 0.99^{a}	23.16 ± 1.13^{a}
	PRO	8.42 ± 0.29^{b}	8.74 ± 0.33^{a}	9.56 ± 0.31^{ab}	11.07 ± 0.91^{ab}	10.20 ± 0.41^{ab}
	GLY	3.21 ± 0.32^{acd}	2.55 ± 0.27^{a}	2.16 ± 0.31	1.88 ± 0.22^{c}	2.33 ± 2.19^{d}
	ALA	3.44 ± 0.34	3.28 ± 0.34	3.18 ± 0.19	3.22 ± 0.28	3.22 ± 0.27
	ARG	4.42 ± 0.42^{abc}	3.86 ± 0.37^{abc}	3.40 ± 0.26^{a}	3.35 ± 0.22^{b}	3.45 ± 0.29^{c}
	Total	52.76 ± 1.19	52.69 ± 1.29	52.80 ± 1.54	52.74 ± 0.79	53.57 ± 1.13

The means with the same superscripts within lines differ at least at P = 0.05 level of probability; bold superscripts indicate significant differences (P < 0.05) between subsequent sampling dates

Table 3. Amino acid profile in Charolais cows' colostrum and transient milk protein (Exp. 2, *n* = 22)

Amino acids		Mean ± standard deviation				
		time *post partum* (hours)				
		0	24	48	72	168
Essentials (%)	TRE	6.34 ± 0.54^{ab}	4.93 ± 0.67^{ab}	4.33 ± 0.41$^{\mathbf{a}}$	4.24 ± 0.33^{b}	4.48 ± 0.63$^{\mathbf{a}}$
	VAL	7.32 ± 0.70^{abc}	6.10 ± 0.60^{abc}	5.63 ± 0.38$^{\mathbf{a}}$	5.38 ± 0.64^{b}	5.25 ± 0.78^{c}
	MET	1.81 ± 0.34^{abcd}	2.38 ± 0.35^{acd}	2.56 ± 0.43^{b}	2.62 ± 0.42^{c}	2.60 ± 0.37^{d}
	ILE	3.71 ± 0.42^{abcd}	4.61 ± 0.53$^{\mathbf{a}}$	4.62 ± 0.29^{b}	4.50 ± 0.41^{c}	4.69 ± 1.00^{d}
	LEU	8.78 ± 0.38$^{\mathbf{a}}$	8.61 ± 0.40^{c}	8.39 ± 0.42^{ad}	8.47 ± 0.53^{b}	8.99 ± 0.88^{bcd}
	PHE	4.00 ± 0.26^{cd}	4.00 ± 0.23^{ae}	4.20 ± 0.26^{ac}	4.18 ± 0.31^{bde}	4.68 ± 0.50^{bde}
	LYS	7.39 ± 0.73^{ac}	7.96 ± 0.53^{ad}	8.37 ± 0.49^{ac}	8.40 ± 0.41^{bd}	7.71 ± 0.48^{bcd}
	HIS	2.20 ± 0.22^{ac}	2.47 ± 0.16$^{\mathbf{a}}$	2.36 ± 0.22^{b}	2.59 ± 0.26^{bc}	2.37 ± 0.28^{c}
	Total	39.90 ± 2.55	39.00 ± 3.34	39.55 ± 1.75	38.6 ± 2.85	39.75 ± 2.20
Semi-essential (%)	CYS	1.74 ± 0.40^{abc}	1.37 ± 0.45^{abc}	1.02 ± 0.35$^{\mathbf{a}}$	1.06 ± 0.33^{b}	1.01 ± 0.38^{c}
	TYR	4.61 ± 0.34^{acd}	4.32 ± 0.30$^{\mathbf{a}}$	4.26 ± 0.64^{c}	4.24 ± 0.36^{bd}	4.53 ± 0.34^{b}
	Total	6.34 ± 0.47	5.69 ± 0.59	5.29 ± 1.31	5.30 ± 0.47	5.52 ± 0.48
Non-essential (%)	ASP	8.18 ± 0.54^{ac}	7.93 ± 0.54^{bd}	7.80 ± 0.50$^{\mathbf{a}}$	7.53 ± 0.60^{bc}	7.38 ± 0.46^{ad}
	SER	7.88 ± 0.57^{ab}	6.39 ± 0.86^{ab}	5.78 ± 0.54$^{\mathbf{a}}$	5.52 ± 0.41^{b}	5.13 ± 0.61^{ab}
	GLU	15.57 ± 1.58^{ab}	18.64 ± 1.56^{ab}	19.96 ± 1.05$^{\mathbf{a}}$	20.89 ± 0.89$^{\mathbf{a}}$	20.36 ± 1.16^{b}
	PRO	8.37 ± 0.85^{ab}	9.84 ± 0.8^{ab}	10.69 ± 0.69$^{\mathbf{a}}$	11.22 ± 1.03$^{\mathbf{a}}$	10.76 ± 0.72^{b}
	GLY	3.37 ± 0.43^{abc}	2.39 ± 0.46^{abc}	2.05 ± 0.28$^{\mathbf{a}}$	1.93 ± 0.13^{b}	2.11 ± 0.30^{c}
	ALA	3.78 ± 0.38^{ac}	3.06 ± 0.24$^{\mathbf{a}}$	3.09 ± 0.29^{b}	2.72 ± 0.28^{ab}	2.89 ± 0.44^{c}
	ARG	3.88 ± 0.51^{abc}	3.45 ± 0.37$^{\mathbf{a}}$	3.34 ± 0.40^{b}	3.51 ± 1.19	3.25 ± 0.40^{c}
	Total	51.04 ± 1.09	51.71 ± 1.33	52.75 ± 1.09	53.34 ± 1.88	51.90 ± 1.04

The means with the same superscripts within lines differ at least at $P = 0.05$ level of probability; bold superscripts indicate significant differences ($P < 0.05$) between subsequent sampling dates

(TYR)) and non-essential (aspartic acid (ASP), serine (SER), glutamic acid (GLU), proline (PRO), glycine (GLY), alanine (ALA), arginine (ARG)) amino acids.

Experimental data were processed by the software of SPSS.10 statistical program package. Statistical analysis was done by MANOVA, LSD-test and Curve Regression.

RESULTS AND DISCUSSION

Mean values and standard deviations of different amino acids in colostrum and transient milk protein of Charolais cows are shown in Table 2 and 3 according to the years. Comparison of these data with results of different breeds investigated by other authors is not informative enough due to the effect of different years and farms.

Changes in the amino acid profile of colostrum and transient milk protein during the first week *post partum* were analysed by LSD-test. Results are presented in Table 2 and 3.

Essential amino acids

TRE concentration in colostrum and transient milk protein showed a decreasing tendency for 48 (Exp. 2) or 72 hours (Exp. 1) after parturition. VAL content of protein decreased until the first (Exp. 1) or second (Exp. 2) day of the week *post partum*. An increasing tendency was observed for MET (Exp. 1:0–0.72 hours; Exp. 2:0–0.24 hours). PHE concentration remained constant in the first 24 hours, but significant increases were recorded between hours 24 and 72 (Exp. 1) or 168 (Exp. 2). ILE content showed a rapid increase during the

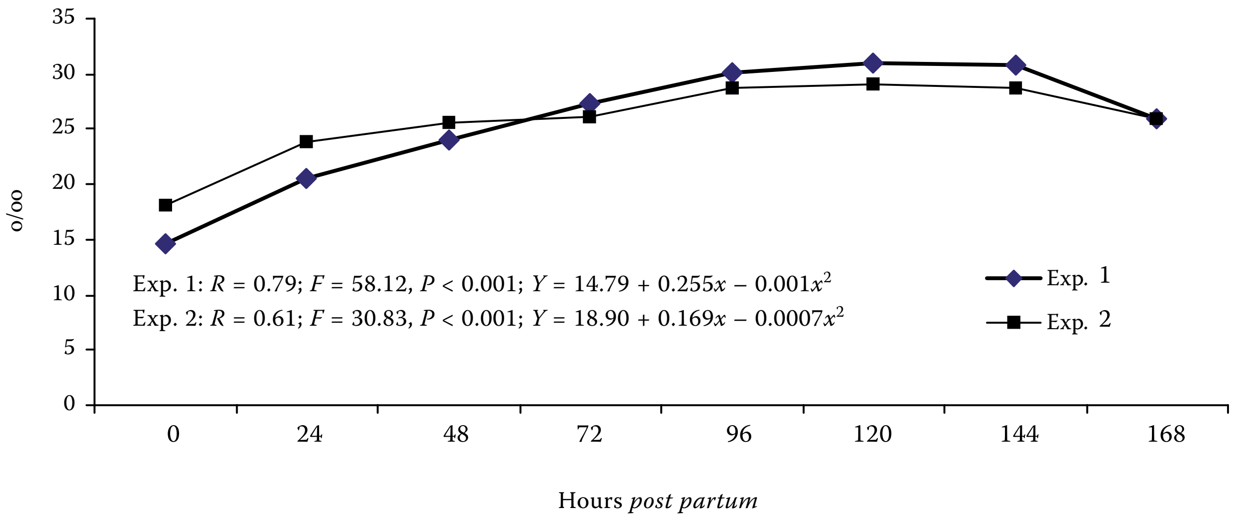

Figure 1. Methionine content in colostrum and transient milk protein of Charolais cows

first days as well, then a slower growth was recorded until the 168th hour. LYS concentration in protein increased for 48 hours after calving, and by the end of the week (72–168 hours) a decrease was observed which was significant only in Exp. 2. In Exp. 1, HIS concentration was constant in the week after parturition, however, in 2003 a marked increase was found in the first 72 hours, followed by a decrease until the end of the week.

The total of essential amino acids did not change significantly during the experimental periods. This result differs from that published by Szentpéteri et al. (1986), who recorded a rapid decrease in the total of essential amino acids during the first 3 days after parturition.

Among essential amino acids, only the changes of PHE and MET could be described by quadratic equations. Results of curve regression analysis are presented in Figure 1 and 2. Determination coefficients were moderate ($R = 0.60–0.79$), but significant ($P < 0.001$) in both Exp. 1 and 2. A larger number of samples could make it possible to find an equation for the estimation of PHE and MET under certain environmental circumstances.

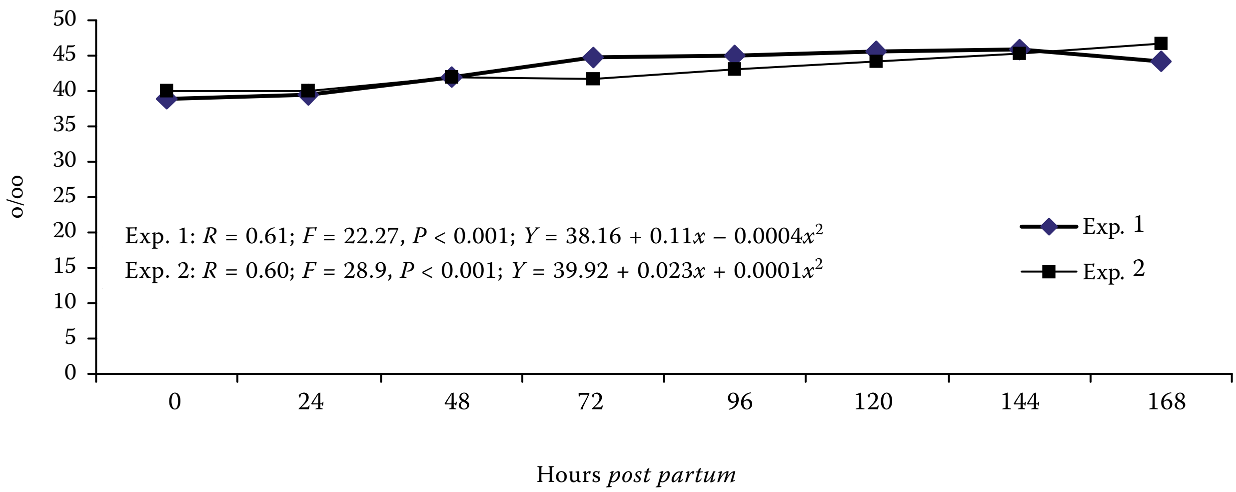

Figure 2. Phenylalanine content of colostrum and milk protein in the first week after calving

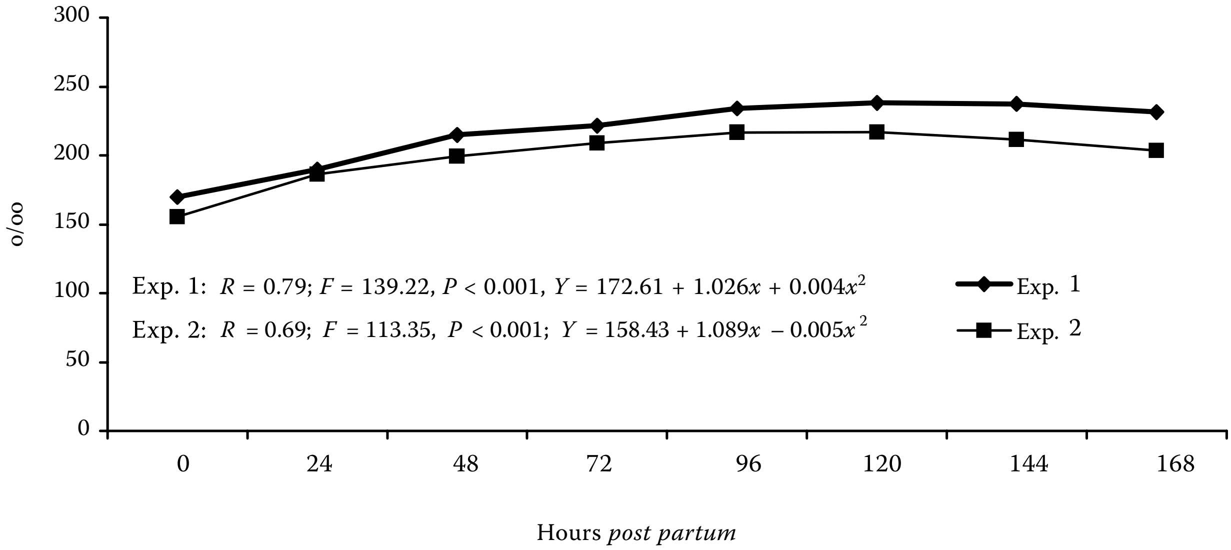

Figure 3. Glutamic acid concentration in colostrum and transient milk protein of Charolais cows in the first week after parturition

Semi-essential amino acids

Semi-essential amino acids are produced by animal cells on condition essential amino acids are provided as precursors.

CYS content of colostrum and milk protein decreased until the second (Exp. 1) or third (Exp. 2) day after calving. In the level of TYR, a marked increase was observed between hours 48 and 72 in Exp. 1. In Exp. 2, TYR content of protein decreased by the 24th hour and this tendency was in fact similar in Exp. 1, but it was not significant. From the third to the seventh day *post partum*, increasing TYR content was recorded in Exp. 2.

The total of semi-essential amino acids showed a decreasing tendency ($P < 0.05$) in the first 48 hours after calving in both experiments.

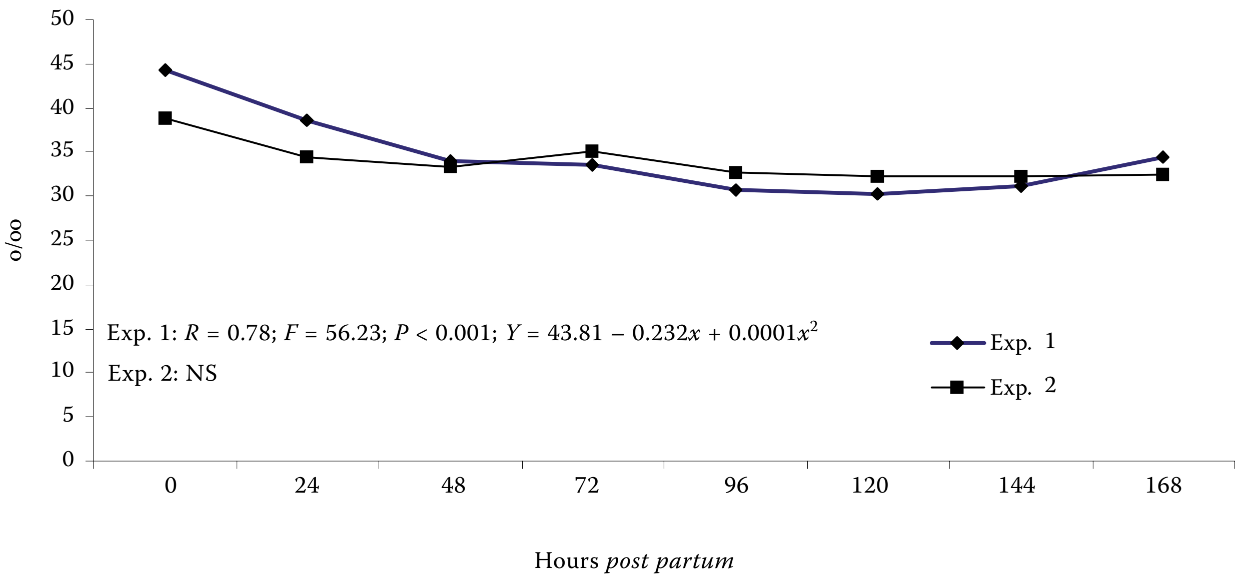

Figure 4. Concentration of arginine in colostrum and milk protein

Non-essential amino acids

Among non-essential amino acids, SER decreased in the colostrum and milk protein during the first week after calving in both experiments. The tendency was the same for ASP as well, but it was significant only in Exp. 1. In GLY, only a slight decrease was found ($P < 0.1$) by the 24th hour in Exp. 1 while in Exp. 2 it was significant in the first 48 hours ($P < 0.05$). ARG showed a decreasing tendency in the first 48 hours. Significantly increasing tendencies were obtained for GLU during the whole week in Exp. 1, and in the first 3 days in Exp. 2. PRO content of protein increased significantly between the 48th and 72nd hours *post partum* in Exp.1, and throughout the first 72 hours in Exp. 2. The level of ALA did not change significantly in the week after calving in Exp. 1, but in Exp. 2 it decreased until the third day. Concentration of GLU could be described by quadratic equations in both experiments (Figure 3, $R = 0.69–0.79$; $P < 0.005$). However, in the case of ARG the equation was valid only in Exp. 1 (Figure 4). No other non-essential amino acids followed the quadratic pattern.

In general, increasing tendencies were obtained in the days after calving for MET, ILE, LYS, and PHE among the essential amino acids, and for GLU and PRO among the non-essentials. These tendencies are similar to those published by Szentpéteri et al. (1986), and Davis et al. (1994) in dairy breeds. Clear decreases were found in VAL, CYS, ASP, SER, GLY and ARG content. These results are similar to those of Arzumanjan and Timofejeva (1972), Szentpéteri et al. (1986) and Davis et al. (1994). It often happened that tendencies were similar in the subsequent experiments, but in one of them the change was not significant (e.g. GLU, PRO, GLY, VAL, LYS). This implies that more cows have to be involved into the study in the next years to get more exact tendencies.

Results were inconsistent for LEU, HIS, TYR, and PHE in the two experiments. However, concerning these amino acids, various tendencies were published by other authors as well. Szentpéteri et al. (1986), similarly to the result of Exp. 1, noted no change in HIS content of colostrum and milk protein during the first week after calving, while Arzumanjan and Timofejeva (1972) observed a decreasing tendency in the first 10 days. TYR and ALA content decreased according to the results of Arzumanjan and Timofejeva (1972), and a decrease was published by Szentpéteri et al. (1986) and Davis et al. (1994).

CONCLUSIONS

After calving, increasing tendencies were observed for methionine, isoleucine, lysine, phenylalanine, glutamic acid and proline content of the colostrum and transient milk protein.

Concentrations of valine, cysteine, aspartic acid, serine, glycine, and arginine decreased in the protein fraction.

Changes in phenylalanine, methionine, and glutamic acid during the first week after calving could be described by quadratic equations in both experiments.

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