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Short communication

Effect of age and stage of lactation on whey protein content in milk of cows of different breeds

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Abstract

The aim of the study was to determine the effect of age of cows, i.e. subsequent lactation and stage of lactation, on bioactive whey protein content in milk of dairy cows of six primary breeds kept in Poland. In all cases the significant correlations between lactoferrin concentration in milk and stage of lactation was stated. Its content gradually increased with the course of lactation but the changes in the content of this protein were highly dependent on breed of cows, what was indicated also by high interactions between breed and stage of lactation.

Key words: whey proteins, breed of cows, lactation, stage of lactation

Introduction

Nowadays, twelve breeds of cattle are in use in Poland, while the milk production is dependent mainly on the Polish Holstein-Friesian breed. In some regions of Poland (mountain, submountain, Bug River) local breeds of cattle dominate. The productivity of cows and physico-chemical parameters of milk are influenced not only by breed of cows and feeding system but also by physiological factors such as age and stage of lactation (Heck et al. 2009). The aim of the study was to determine the effect of age of cows, i.e. subsequent lactation and stage of lactation on bioactive whey protein content in milk of dairy cows of different breeds.

Materials and Methods

The research included 2,638 milk samples collected from five different breeds of dairy cows, i.e. three breeds with primary international importance (Black and White variety of Polish Holstein-Friesian – 719 samples, Jersey – 356 and Simmental – 629) and two local breeds (Polish Red – 497 and Whitebacked – 437). For further analyses the milk samples in which somatic cell count (SCC) did not exceed 400,000 cells/ml (Somacount 150) were taken. The content of whey proteins, i.e. α-lactoalbumin (α-LA), β-lactoglobulin (β-LG), bovine serum albumin (BSA), lactoferrin (Lf) and lysozyme (Lz), were determined by the RP-HPLC method. Evaluating the effect of subse-

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Table 1. Milk yield, SCC and selected whey proteins content in milk of analyzed cow breeds with regard to subsequent lactation and stage of lactation ($\bar{x}$ ± SD).

Breed	Black and White variety of Polish Holstein-Friesian				Simmental				Jersey				Polish Red				Whitebacked			
Lactation																				
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
β-LG	2.97^{b}	2.94^{ab}	2.97^{ab}	2.92^{a}	3.50^{B}	3.42^{AB}	3.40^{AB}	3.35^{A}	3.20^{ab}	3.31^{b}	3.26^{ab}	3.17^{a}	3.52^{b}	3.51^{b}	3.43^{b}	3.25^{a}	3.40	3.31	3.41	3.30
(g/l)	0.30	0.28	0.31	0.35	0.38	0.38	0.43	0.41	0.41	0.60	0.34	0.44	0.54	0.51	0.56	0.55	0.52	0.57	0.47	0.56
α-LA	0.98^{B}	0.95	0.96^{AB}	0.97^{AB}	1.13^{b}	1.10^{ab}	1.11^{ab}	1.08^{b}	1.06	1.06	1.07	1.04	1.11^{b}	1.16^{b}	1.11^{b}	1.04^{a}	1.06	1.05	1.07	1.02
(g/l)	0.12	0.13^{A}	0.13	0.14	0.14	0.16	0.14	0.16	0.15	0.13	0.12	0.15	0.18	0.19	0.20	0.21	0.16	0.19	017	0.18
BSA	0.43^{A}	0.45^{B}	0.46^{B}	0.49^{C}	0.44	0.45	0.45	0.47	0.46	0.46	0.48	0.50	0.42	0.43	0.43	0.45	0.46	0.47	0.45	0.47
(g/l)	0.12	0.14	0.14	0.17	0.11	0.12	0.12	0.14	0.12	0.11	0.13	0.14	0.15	0.12	0.10	0.14	0.13	0.16	0.11	0.14
Lf	78.6^{A}	83.3^{AB}	86.9^{B}	96.2^{C}	117.3^{a}	118.5^{ab}	121.2^{ab}	125.5^{b}	96.6	97.1	97.9	99.5	127.6	126.8	127.7	130.3	120.9	123.6	123.7	125.7
(mg/l)	22.1	21.3	22.9	23.1	20.7	23.9	22.1	20.90	16.3	18.9	18.1	18.1	34.0	32.1	28.4	26.2	18.4	21.2	22.8	21.0
Lz	7.3^{a}	7.86^{ab}	8.13^{ab}	9.10^{b}	10.38	10.34	10.22	10.66	12.60	12.61	12.30	13.00	11.83	11.22	11.29	12.72	11.57	11.89	12.15	12.88
(μg/l)	3.53	4.35	4.41	4.41	2.30	2.56	2.09	2.62	2.56	3.25	2.75	3.82	6.39	4.65	5.04	5.90	5.56^{a}	7.38^{ab}	4.17^{ab}	7.09^{b}
SCC	122^{A}	143^{A}	183^{B}	250^{C}	117^{a}	143^{ab}	162^{b}	163^{b}	113	121	137	139	147^{a}	166^{ab}	170^{ab}	199^{b}	130^{a}	128^{a}	141^{ab}	180^{b}
(thous./ml)	122	118	110	128	96	103	147	124	98	111	110	116	140	113	138	164	93	77	98	124

Stage of lactation	Black and White variety of Polish Holstein-Friesian			Simmental			Jersey			Polish Red			Whitebacked		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
β-LG	2.95	2.96	2.96	3.42	3.40	3.36	3.20	3.27	3.24	3.46^{B}	3.36^{AB}	3.24^{A}	3.31	3.21	3.23
(g/l)	0.32	0.31	0.29	0.39	0.40	0.41	0.50	0.50	0.42	0.54	0.55	0.56	0.57	0.57	0.53
α-LA	0.96	0.97	0.97	1.12^{C}	1.10^{B}	1.07^{A}	1.06	1.04	1.07	1.11^{B}	1.09^{AB}	1.04^{A}	1.03	1.01	1.00
(g/l)	0.13	0.13	0.13	0.15	0.15	0.16	0.14	0.13	0.12	0.21	0.18	0.19	0.19	0.16	0.17
BSA	0.46	0.45	0.45	0.45	0.46	0.48	0.50^{b}	0.50^{b}	0.47^{a}	0.43	0.42	0.44	0.46	0.49	0.48
(g/l)	0.14	0.13	0.15	0.12	0.13	0.13	0.14	0.12	0.12	0.17	0.12	0.15	0.14	0.17	0.13
Lf	80.2^{a}	82.4^{a}	86.8^{b}	109.2^{A}	117.9^{B}	129.0^{C}	91.8^{A}	99.5^{B}	101.3^{B}	114.4^{A}	129.7^{B}	140.0^{C}	117.1^{A}	126.17^{B}	130.55^{B}
(mg/l)	16.7	17.6	21.2	17.4	19.9	21.8	14.2	17.5	17.6	21.7	28.5	32.2	15.8	21.1	22.9
Lz	7.94	8.15	8.55	10.41	10.32	10.66	12.82	13.24	12.68	11.59	12.38	12.69	12.29	12.58	12.70
(μg/l)	2.52	1.91	2.62	2.66	2.35	2.52	3.34	3.43	2.85	5.26	6.09	6.07	6.03	7.00	6.67
SCC	152^{a}	178^{ab}	209^{b}	144	144	153	122	148	133	154	189	180	131	159	155
(thous./ml)	126	114	117	123	121	113	102	132	100	153	190	170	108	115	98

Interactions (p)	Breed x subsequent lactation	Breed x stage of lactation	Subsequent lactation x stage of lactation	Breed x subsequent lactation x stage of lactation
β-LG	0.000	0.001	0.187	0.342
α-LA	0.000	0.001	0.052	0.146
BSA	0.033	0.490	0.428	0.605
Lf	0.053	0.000	0.228	0.020
Lz	0.009	0.445	0.770	0.947
SCC	0.037	0.605	0.427	0.919

a, b, A, B – differences between subsequent lactation within breed; a, b – differences significant at p ≤ 0.05; A, B – differences significant at p ≤ 0.01

quent lactation and its stage on content of analyzed components, four classes of age were established: 1 – cows in lactation I, 2 – II, 3 -III and 4 – IV-VI as well as three stages of lactation, i.e.: 1 – to 120 days, 2 – 121-200 days and 3 – 201-305 days. The results obtained were analyzed using Statistica ver. 6.

Results and Discussion

With the age of cows, an increase in SCC was noted, and in the case of cows of local breeds and Jersey that rise was much smaller in comparison to Polish Holstein-Friesian cows (Table 1). This confirms somewhat higher resistance of local breeds of cows to inflammation (Litwińczuk et al. 2011). In most breeds the content of albumin, i.e. β-LG and α-LA, was reduced significantly with following lactation. Similar tendencies were also observed during the course of lactation. The decline in α-LA content may be due to a decrease in milk production in late lactation, as this protein is a component of lactose synthase complex (Caffin et al. 1985). In the case of BSA the different dependences were noticed, i.e. its content increased with the age of cows, however, the significant differences were found solely in the milk of Holstein-Friesian cows. According to Litwińczuk et al. (2011), the BSA content is an indicator of permeability of the blood-milk barrier in the mammary gland. The main factor that increases the permeability is an inflammation of udder. Bearing in mind that in the study SCC did not exceed 400 thous./ml, it can be assumed that the age of cows also affects the permeability of the epithelium of mammary gland. Most likely it is associated with previous inflammations, which caused the damage to the epithelium and increase its permeability, even after recovery. With the subsequent lactation concentrations of the major antimicrobial proteins (Lf and Lz) also increased, however, the significant differences were noted in the milk of highly productive breeds of cows, i.e. Holstein-Friesian. These differences may be associated with significant increase in SCC with age of cows. In all cases the significant correlations between Lf concentration in milk and stage of lactation was found. Its content gradually increased with the following of lactation but the changes in content of this protein were highly dependent on breed of cows, what was indicated also by high interactions between breed and stage of lactation. Within lactation two-fold higher differences in concentrations of Lf were found in milk of cows of Simmental and local breeds.

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