ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. XXI, N2, 96 SECTIO EE 2003

Laboratory of Reproduction Biology, Chair of Animal Hygiene and Environment
Department of Animal Biology and Breeding, Agricultural University of Lublin
Department of Hygiene and Veterinary Prophylaxy, Podlasie University in Siedlce

WIOLETTA WNUK, JUSTYNA ODÓJ, HANNA BIS-WENCEL,
LEON SABA, BOŻENA NOWAKOWICZ-DĘBEK, TERESA BOMBIK

*Milk and Hair Coat as Indicators of Macroelements Content in Cows at Different Stages of Lactation**

Mleko i sierść jako wskaźniki zawartości makroelementów
u krów w różnych stadiach laktacji

Macroelements supplied to animals in natural and commercial feeds as well as in the form of mineral supplements are not always sufficient, which affects health, performance and reproduction. High-producing animals are particularly sensitive. This is often due to strong exhaustion during the course of intense lactation (4, 8).

The aim of this experiment was to determine the macroelements content of milk and hair coat of cows depending on their physiological status to further explore the possibility of evaluating the mineral supply to the body.

MATERIAL AND METHODS

Five dairy farms in the region of Central Pomerania were investigated. They were designated as „A", „B", „C", „D" and „E". The cows were of the Black-and-White breed with different Holstein-Friesian inheritance, aged from 2 to 5 months. They had similar breeding parameters and were at different physiological stages. 10 equivalent cows were chosen from each herd, including 5 cows at different but close stages of lactation and 5 cows that came into lactation after parturition. Samples of milk and hair coat were taken to determine their mean content of macroelements Ca, P, Mg, Na and K. Milk was sampled four times after previous clinical examination of the udder with the California mastitis test. Hair coat was sampled three times according to the Brochart method (hair regrowth was taken at the height of withers after previous shaving (3). The content of minerals (Ca, Mg, Na, K) was determined with ASA-Unican 939 and inorganic phosphorus according to Fiske-Subbarov.

* This work was conducted as part of the project no. 5PO6K02119.

To determine macroelements contents in the food chain, the soil and feed were sampled. The soil was collected once from a 0–15 cm deep layer at the height of the vegetative period, while the feeds were sampled regularly upon their introduction into dietary units. A rule of sample representativeness was observed. Over the research period the analyses on soil mineral availability were conducted as well as on feedstuff fed to cattle. The content of Ca, Mg, Na and K was determined after ASA method, whereas the phosphorus level according to Fiske-Subbarovs' method.

Animal feeding was performed in compliance with the standards required (9).

The numerical data were analyzed statistically. The values of traits were characterized by arithmetic means ($\bar{x}$) and standard deviation (*SD*). Significant differences between herds were analyzed with multivariate analysis of variance (ANOVA – F test and NIR ranges).

RESULTS AND DISCUSION

Soil and feeds are the main source of elements for animals (Tables 1 and 2). The elements pass into milk as a result of an exchange between blood and the mammary gland. The content of elements also depends on the physiological status, milk yield and udder health (6, 7).

Table 1. Results of tests on *pH* (in 1M KCL) and mineral composition of grassland soils in farms A, B, C, D, E

Farm	Type of soil	n	*pH*		Ca	P	Mg	K
					in g/kg d.m.			
A	Alluvial	25	6.1	$\bar{x}$	12.0	2.1	2.1	2.8
				SD	2.0	0.3	0.3	0.2
B	Podzolic from clayey forms	25	6.0	$\bar{x}$	13.2	2.4	1.8	2.5
				SD	3.1	0.4	0.3	1.4
C	Peat	25	6.0	$\bar{x}$	11.0	2.1	1.8	1.8
				SD	2.0	0.4	0.3	0.3
D	Rendzina	25	6.2	$\bar{x}$	13.4	2.0	1.7	2.8
				SD	4.0	0.4	0.4	0.3
E	Loams of aqueous origin	25	5.8	$\bar{x}$	14.4	2.2	1.5	2.1
				SD	3.1	0.2	0.2	0.4

n – no. of bulk samples; A, B, C, D, E – herd symbols

The present experiment demonstrated that as the lactation proceeded, the level of all macroelements studied slowly decreased in both group I (cows in successive, later stages of lactation) and group II (postparturient cows that came into lactation – 1,3,6 and 9 weeks) (Table 3). It was also noted that the milk of cows from group II was characterized by higher levels of Ca, P, Na and Mg than that of

Table 2. Levels of minerals in cattle feeds on farms A, B, C, D, E (g/kg d.m.)

Type of soil studied	n		Ca					P					Mg					Na					K				
			A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Meadow hay	20	$\bar{x}$	4.5	5.2	5.0	5.2	4.5	2.1	2.0	1.6	1.9	1.5	2.1	1.9	1.7	1.7	1.6	2.2	2.0	1.8	2.1	1.9	24.3	20.8	25.3	26.0	23.3
		SD	0.8	0.8	1.2	0.6	1.0	0.4	0.2	0.5	0.3	0.4	0.4	0.3	0.1	0.2	0.3	0.2	0.4	0.3	0.5	0.3	3.2	1.4	4.2	5.1	3.3
Pasture forage	20	$\bar{x}$	5.3	5.8	4.7	4.6	5.2	1.4	1.9	2.0	1.5	1.4	2.1	2.1	1.8	1.6	1.8	2.3	2.4	1.9	2.2	2.2	23.0	20.0	23.4	22.5	20.0
		SD	0.7	1.3	0.5	1.0	0.9	0.2	0.8	0.8	0.2	0.6	0.3	0.3	0.2	0.2	0.1	0.4	0.6	0.5	0.7	0.4	2.2	2.1	3.1	5.5	2.2
Farm-produced concentrate	20	$\bar{x}$	11.2	8.6	9.2	10.2	9.9	8.8	9.1	7.1	8.2	6.8	7.0	5.2	6.3	6.7	5.5	2.1	4.2	3.2	3.0	3.5	5.9	6.3	8.2	7.1	6.1
		SD	0.6	1.4	0.4	1.5	0.5	0.3	1.2	0.1	0.3	0.4	1.0	0.7	0.3	0.9	0.5	0.6	0.9	0.7	0.6	0.8	2.1	1.8	2.3	2.3	2.0
Barley-oat straw	20	$\bar{x}$	1.7	2.1	1.5	1.7	1.5	0.3	0.4	0.3	0.4	0.3	0.4	0.2	0.3	0.4	0.2	2.1	1.3	1.0	0.5	0.9	5.0	6.4	6.2	4.8	5.1
		SD	0.2	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.1	0.3	0.2	0.1	0.1	0.3	0.4	2.5	1.2	1.1	0.6	1.3
Dry sugar beet pulp	20	$\bar{x}$	10.3	8.9	7.8	9.2	8.2	1.9	0.5	1.1	0.9	0.5	0.5	0.8	0.3	0.2	0.4	2.2	2.6	2.3	1.8	1.5	17.0	18.5	19.2	19.3	20.1
		SD	1.1	0.6	0.8	1.2	0.9	0.3	0.2	0.2	0.1	0.3	0.2	0.3	0.1	0.1	0.2	0.5	1.1	0.5	0.6	0.5	2.3	1.2	2.1	0.9	1.3
Fodder beets	20	$\bar{x}$	9.2	7.1	8.2	9.4	7.7	2.2	2.0	1.9	1.5	1.6	2.1	0.8	1.2	0.9	0.6	0.9	1.3	1.2	1.5	1.4	2.1	2.2	4.2	4.4	5.0
		SD	1.0	0.9	1.1	1.0	0.6	0.2	0.1	0.8	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.1	0.6	0.3	0.6	0.8	0.5	1.5	1.2	0.9

Table 3. Mean content of macroelements (Ca, P, Mg, Na, K) in milk and hair coat of cows

	Element	Sample	Group I - lactation		Group II - early lactation		Comparison of groups		
			$\bar{x}$	*SD*	$\bar{x}$	*SD*	difference in means	t	P_1
Milk mg/100ml	Ca	I	159.4	6.76	174.0	7.21	14.6	7.36	<0.001
		II	152.1	8.84	165.6	8.69	13.5	5.44	<0.001
		III	147.4	8.18	163.8	11.74	16.4	5.72	<0.001
		IV	142.6	7.55	160.4	10.30	17.8	6.94	<0.001
	P	I	28.29	1.14	33.50	2.72	5.21	8.84	<0.001
		II	27.40	1.12	32.48	2.55	5.08	9.11	<0.001
		III	26.38	1.12	31.31	2.36	4.93	9.44	<0.001
		IV	25.18	1.46	29.42	1.65	4.24	9.64	<0.001
	Na	I	30.04	2.74	32.92	2.15	2.88	4.13	<0.001
		II	29.44	2.26	31.56	2.22	2.12	3.36	<0.01
		III	28.58	2.06	30.51	2.13	1.93	3.24	<0.01
		IV	27.66	1.72	28.92	1.61	1.26	2.67	<0.02
	K	I	178.0	6.16	176.5	22.16	-1.5	0.33	>0.74
		II	175.3	6.98	172.6	20.54	-2.7	0.63	>0.52
		III	173.1	6.16	169.0	18.83	-4.1	1.04	>0.30
		IV	170.5	7.40	173.6	5.31	+3.1	1.68	>0.009
	Mg	I	24.33	1.51	28.78	2.08	4.45	8.65	<0.001
		II	23.78	1.33	27.11	1.67	3.33	7.80	<0.001
		III	22.69	1.20	24.56	3.28	1.87	2.68	<0.02
		IV	22.30	2.41	21.36	3.31	-0.94	1.15	>0.25
Hair coat mg/kg s.m.	Ca	I	871.00	46.57	858.64	72.64	-12.36	3.79	<0.001
		II	889.04	51.052	850.72	43.48	-38.32	6.18	<0.001
		III	957.88	38.46	896.12	72.10	-61.76	5.69	<0.001
	P	I	182.28	24.70	173.44	14.44	-8.84	4.06	<0.005
		II	179.52	8.45	168.84	9.81	-10.68	5.60	<0.001
		III	213.24	19.39	197.40	23.59	-15.84	7.82	<0.001
	Na	I	439.88	56.39	437.52	64.47	-2.36	8.25	<0.001
		II	424.52	39.21	403.12	33.19	-21.4	16.24	<0.001
		III	461.68	66.68	421.36	58.75	-40.32	7.15	<0.001
	K	I	1881.0	102.97	1842.5	135.82	-38.5	6.55	<0.001
		II	1861.7	81.54	1802.2	81.86	-59.5	7.99	<0.001
		III	1940.4	79.48	1878.8	87.15	-65.6	3.98	<0.001
	Mg	I	230.16	25.94	218.52	40.45	-11.64	3.19	<0.001
		II	223.76	18.63	207.32	13.42	-16.44	8.15	<0.001
		III	296.04	23.26	264.24	45.78	-31.8	6.66	<0.001

$\bar{x}$ – mean value, *SD* – standard deviation, P – significance of differences, t – coefficient of variation

cows in full lactation. Only the level of K failed to reflect this correlation. In samples I, II and III, the mean values were lower than in the samples taken from group I. The level of all macroelements discussed was similar to or slightly higher than that reported by authors discussing the problem of mineral supply in dairy cows (1,2,5,8). This proves that the stores of mineral elements are depleted by intense lactational processes.

The analysis of the content of elements in hair coat, just as in milk, can be a complementary way of determining the mineral status of cows. The accessibility of hair coat and the sampling procedure are largely responsible for the initiation of studies involving hair coat (2). Currently, determination of both macro- and microelements in hair coat should be treated as complementary to blood tests.

Concentration of the elements studied in hair coat showed an upward tendency in both groups I and II as the lactation proceeded. Phosphorus concentration, however, was low and only slightly exceeded 200 mg/kg d.m. in sample III (group I). The level of Mg was also lower than the optimum value of 750 mg/kg d.m. In both groups studied, P and Mg concentrations assumed lower than physiological values (Table 3). This was shown in earlier studies on blood serum (2,8). It is therefore concluded that the analysis of milk and hair coat is helpful or reflects deficiencies in dairy cows from the central Pomerania region.

CONCLUSIONS

1. Under the influence of lactation process a decrease of Ca, P, Mg and Na content in milk of the cows was recorded.

2. The mean values of P and Mg in cows' hairs were lower than those presented by other authors.

3. Milk analysis and hairs are likely to reflect the deficiency status occuring at the cows from the Central Pomorze region.

REFERENCES

1. Baranow-Baranowski S., Klata W.: Wpływ zawartości wybranych składników mineralnych (Ca, P, Mg, Cu, Zn i Co) w paszy na ich poziom w surowicy i mleku krów. Mag. Wet., 3, 198-201, 1998.
2. Bis-Wencel H.: Rozpoznawanie i zapobieganie niedoborom mineralnym u przeżuwaczy w regionie południowo-wschodniej Polski. Rozp. Nauk. AR w Lublinie, 243, 2001.
3. Brochart M.: Investigation of Nutritional Deficiencies and Imbalances by the Chemical Analysis of Hair. Vet. Sci. Comn., 2,183, 1978.
4. Dymnicka M.: Wpływ żywienia krów oraz wielkość produkcji mleka, stadium laktacji i kolejnych laktacji na zawartość wybranych wskaźników biochemicznych we krwi. Praca hab. SGGW, Warszawa 1998.

5. Górska A.: Zawartość wapnia i magnezu w mleku krów z gospodarstw indywidualnych regionu Podlasia. Rocz. Nauk. Zoot., Supl., z. 6, 42-45, 2000.
6. Grega T.: Przechodzenie mikro- i makroelementów zawartych w karmie do mleka. Post. Nauk Rol., 5, 126-138, 1997.
7. Kleczkowski M., Kluciński W., Strzaliński M., Dziekand P., Sikora J.: Ekologia biogeochemiczna a choroby zwierząt, Med. Wet., 51, 8, 443-445, 1995.
8. Tymczyna L., Saba L., Kamieniecki K., Bis-Wencel H., Wnuk W.: Występowanie i rozpoznawanie niedoborów i dysproporcji w gospodarce mineralnej u bydła mlecznego z rejonu Pomorza Środkowego. Annales, sectio EE, vol. 18, 28, 215-221, 2000.
9. Zarudzki R., Traczykowski A., Mroczko L.: DLG – tabele wartości pokarmowej pasz i norm żywienia przeżuwaczy. Wyd. PPH VIT-TRA, Kusowo 2001.

STRESZCZENIE

Badania dotyczące niedoborów makroelementów w mleku i sierści krów przeprowadzono w rejonie Pomorza Środkowego. Materiał badawczy stanowiły dwie grupy krów mlecznych, wytypowane metodą analogów, w różnym stanie fizjologicznym: grupa I – krowy w pełnej laktacji, grupa II – krowy, które po porodzie weszły w stadium laktacji. Wszystkie zwierzęta zgrupowano w pięciu fermach „A", „B", „C", „D" i „E". Oznaczenia zawartości makroelementów (Ca, P, Mg, Na, K) wykonano w próbkach mleka i sierści. Uzyskane wyniki dowodzą, że u krów z badanego regionu występują niedobory mineralne, dotyczące szczególnie zawartości Mg i P, co wiąże się bezpośrednio z warunkami biogeochemicznymi, jak i składem podawanej paszy. Stan fizjologiczny krów miał również wpływ na poziom badanych pierwiastków. W miarę nasilającej się laktacji ich poziom ulegał powolnemu spadkowi zarówno w grupie I, jak i II. Oznaczanie makroelementów w mleku i sierści powinno być traktowane jako uzupełnienie badań krwi.