Animal Science Papers and Reports vol. 26 (2008) no. 3, 199-209
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Macro- and microelements in milk and hair of cows from conventional *vs.* organic farms

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(Received March 15, 2008; accepted July 29, 2008)

Considered were four dairy farms. Two were certified organic farms and two were conventional – one with intensive and one with extensive production system. Observations were conducted on 10 Holstein-Friesian (HF) cows from each farm while from conventional farm with extensive production additional 10 Polish Red (PR) cows were observed. Samples of milk and hair for determination of minerals were collected in September. Hair samples were taken from the poll. Twenty-nine elements – Ca, K, Mg, Na, P, S, B, Ba, Co, Cr, Cu, Fe, Ge, I, Li, Mn, Mo, Ni, Se, Si, Sn, Sr, V, Zn, Al, As, Cd, Hg, and Pb – were determined in milk and hair. The concentrations of Ca, Mg and P in milk were highest in intensive production system with no grazing, compared with conventional and both ecological farms with pasture feeding. The highest concentrations of I, Mn, Sr, V, and Zn in milk were found on conventional intensively producing farm, while those of Li, Si, Sn, Ba, and Ge on both organic farms. The highest concentrations of B, Be, Co, Fe, Ge, and Li in cow hair were found on organic farm, and highest concentration of Cr, I, Mo, Se, Sn, Sr, V, and Zn on conventional farm with extensive production. The highest levels of Cd and Pb in milk were found on conventional farm with extensive production. Generally, the levels of all toxic elements in milk appeared low and below admissible. The results presented suggest that the mineral composition of cow milk and hair depended on production system followed on the farm.

KEY WORDS: cow / hair / macro-and microelements / milk / organic farms

From among more than a hundred elements occurring in nature four organically bound elements (carbon, hydrogen, oxygen and nitrogen) make up 96% of the animal's body weight. The principal cations and anions together account for 3.5% of the body weight, the remainder comprising another mineral elements. The progress in analytical methods has led to elucidation the biological role of many elements occurring in plant,

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animal and human organisms. Distribution of minerals within the body tissues is not uniform, since some tissues selectively concentrate specific elements. There is no disagreement concerning the essential nature of major and trace elements in livestock. The essentially toxic elements: aluminium (Al), arsenic (As), cadmium (Cd), fluorine (F), lead (Pb), mercury (Hg) are known principally for their toxic properties, while occasionally fulfilling the criteria of an essential element for livestock [Underwood and Suttle 1999]. The new trace elements were discovered using highly purified diets and metal-free isolator systems. These elements have not been shown to be essential for livestock or humans consuming typical diets [McDowell 1992]. As nutritional and biochemical techniques continue to become more refined, some of these "accidental" mineral elements will probably become additions to the essential list. Four broad types of function for minerals exist: structural, physiological, catalytic and regulatory, although they are not exclusive to particular elements and many may be discharged by the same element in the same individual [Underwood and Suttle 1999].

The value of the so far applied routine analyses of whole blood, serum and urine for bioelements is limited. Blood mineral level often does not correspond to their contents in the whole body, because the composition of plasma results from supplementation of deficiencies by different homeostatic mechanisms. Moreover, the blood bioelements concentration is relatively low and depends on the current diet, thus the diagnostic value of the analytical results may be fairly small [Bland 1984]. Studies have shown that the analysis of hair and nails are an appropriate alternative for the analysis of blood and urine, and for biopsy [Passwater and Cranton 1983, Bland 1984]. The mineral element status in the sheep's flock determined by wool analysis can be a good method [Kośla *et al.* 1988] as the content of mineral elements of the wool showed significant differences between Booroola and Polish Merino ewes [Gabryszuk *et al*. 2001]. The concentrations of the same minerals in the blood plasma of the same ewes were within the reference values, and no significant differences were observed between breeds [Gabryszuk *et al*. 2001]. The mineral contents of wool was reported to depend also on physiological status (parturition, gestation, mating) of sheep [Gabryszuk *et al*. 2000]. The diagnostic value of hair analysis is confirmed by many authors who have demonstrated the correlation between the levels of principal elements in hair and their contents of the body, both under the physiological equilibrium and during pathological disturbances [Bland 1984, Radomska *et al*. 1993, 2005]. Milk is important in satisfying the nutritional demands of mammalian neonates. Data on minerals are limited in identifying the nutrients in milk required for optimum growth and health of mammalian species, including humans [Anderson 1992]. Chemization in agriculture, animal production and food processing introduces a galore of contaminants into the food chain. Therefore, organic methods in agriculture are safer and thus very important. Nutrition based on the organically produced foods and anthroposophic lifestyle can play an important role in prophylaxis [Rembiałkowska 2003]. We wanted to check hypothesis that animals and food products from organic farms should contain more essential and less toxic bioelements than products obtained under intensive conditions.

The objective of this study was to determine the effect of different production systems on contents of major and trace elements in cow's milk and hair. Conducted investigations were preliminary.

Material and methods

Cows kept in four dairy farms were chosen for observation (Tab. 1). Two farms (III and IV) were certified organic farms while another two (I and II) were included for comparison. Farm I, with intensive conventional feeding and high yield of cows represented modern, intensive dairy farming. Conventional was also farm II, but feeding applied and production intensity achieved there were comparable with the two organic farms (III and IV). Moreover, the cows on farm II were of two breeds – Polish Holstein-Fresian (HF) and Polish Red (PR). In the remaining farms only HF cows were kept. All of the herds were under official milk recording system, provided by the Polish Society of Cattle Breeders and Dairy Farmers.

Table 1. Production system and feeding of cows on the farms

Item	Conventional		Organic	
	Farm I	Farm II	Farm III	Farm IV
Production	Intensive	Extensive	Extensive	Extensive
Nutrition	TMR feeding	Traditional	Traditional	Traditional
Pasture	No	Yes	Yes	Yes
Silage	TMR	Yes	Yes	No

Table 2. Cows' yield on the day of milk and hair sampling (SD in parentheses)

Item	Conventional		Organic	
	Farm I	FarmII	Farm III	Farm IV
Herd size (heads)	137	80	40	12
Cows sampled	10	20	10	10
Primiparous	4	5	2	2
Multiparous	6	15	8	8
Lactation day of sampling	162 (120)	117 (90)	191 (91)	173 (74)
Milk yield (kg/day)	28.9 (10.4)	17.2 (5.2)	14.0 (4.0)	14.4 (3.5)
Protein (%)	3.47 (0.55)	3.45 (0.29)	3.44 (0.22)	3.27 (0.25)
Fat (%)	3.97 (0.96)	4.15 (0.49)	4.57 (0.53)	4.19 (0.68)

All the farms were located in one climatic zone and under similar soil conditions, but differed in production technology, including level of fertilization and crop rotation. In most of the herds cows were kept in traditional tied-up barns. Feeding was traditional, with ration components offered separately. With exception for farm I, cows were grazed from May to October. Depending on pasture yield and availability of other feeds, feeding ration was supplemented by hay, straw, silage and cereals. In farm I, where cows were kept in a cubicle barn, animals were fed with a total mixed ration (TMR) from a feeding wagon around the year. Milk yield and its composition reflected different environments and feeding intensity in the observed herds (Tab. 2). In each of the herds number of primiparous cows in the sampled group was proportional to the primiparous cows in the whole herd. Within parity groups (either primiparous or multiparous) cows were chosen randomly for sampling. In farm I, III and IV, 10 cows were chosen per herd. In farm II, where two different breeds were kept, 10 cows of each breed were chosen (Tab. 2). Thus, a total of 50 cows were considered.

Samples of milk and hair for analyses of minerals were collected once from each cow in September, *i.e*. during pasture feeding. The hair sample was taken from poll, then washed with acetone (pure for analysis) and three times rinsed with deionized water. The concentration was determined of Ca, K, Mg, Na, P, S, B, Ba, Co, Cr, Cu, Fe, Ge, I, Li, Mn, Mo, Ni, Se, Si, Sn, Sr, V, Zn, Al., As, Cd, Hg, and Pb. Samples of hair (0.3 g) and milk (1 ml) were mineralized in a mixture of 4 ml HNO_3 and 1 ml H_2O_2 in hermetic high-pressure vessels by heating in a microwave oven. Mineral elements content was detected by inductively coupled plasma atomic emission spectroscopy (ICP-AES) Optima 5300 DV, PERKIN ELMER.

Preliminary statistical evaluation showed no significant effect of breed, parity and milk yield on the content of minerals of cows' hair and milk. Thus, the final statistical assessment was based upon the following simple fixed model:

$$y_{im} = S_i + e_{im}$$

where:

y_{im} – content of given element;

S_i – fixed effect of i-th herd (i = 1, 2, 3, 4);

e_{im} – random error.

The GLM procedure from the SAS package [1999] was used for computation.

Results and discussion

Least squares means (LSM) and their standard errors (SE) for macro- and microelements in milk and hair of cows are shown in Tables 3, 4, 5 and 6.

The concentrations of Ca and P in milk were significantly highest in cows from conventional and intensive production system (farm I) and lowest in cows from conventional and extensive production system (farm II). The content of P in hair was significantly higher in farm I than in farm II, but content of Ca was lower in farm I than in farm II. Puls [1994] reported that hair macroelement levels do not correlate with their dietary intake. Maintaining plasma Ca constant during lactation presents a formidable challenge to dairy cow. If dietary sources of Ca consumed are only of 38% availability and dietary P of 45% availability, the cow must consume, on average, 90 to 100 g Ca and 60 to 70 g P daily just to meet her needs for lactation. Additional 25 to 30 g Ca and 15 to 20 g P must be supplied for daily maintenance of the cow [Horst *et al.* 1997]. During the early weeks of lactation most cows remain under the negative Ca balance. To maintain normal blood plasma Ca level, resorption of bone Ca stores and absorption of Ca from intestine meet the negative Ca balance. Bone Ca mobilization is stimulated by concerted effort of parathyroid hormone (PTH) and 1,25-dihydroxyvitamin D [1,25$(OH)_2$D]. The adaptation process begins with dramatic increase in the plasma concentrations of PTH and 1,25$(OH)_2$D at the onset of hypocalcemia [Horst *et al*. 1997].

The significantly higher levels of Na in milk were found in farm I and farm IV compared to farm II. The same tendency appeared in Na content of hair of examined cows.

The content of Mg was significantly higher in cows from intensive production system without pasture (farm I), compared to cows from conventional and ecological farms with pasture feeding (Tab. 3 and 4). Polish soils are considered to be low or very low in Mg. Soils with low and medium concentration of Mg represent 64% of total soils in Poland [Lipiński 2000]. It can explain the fact that grazed cows showed

Table 3. Least squares means (LSM) and their standard errors (SE) for macroelements content of milk (mg/l)

Macro-element	Farm I		Farm II		Farm III		Farm IV	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Ca	706^{a}	40.7	567^{b}	31.5	704^{a}	43.2	689^{a}	38.6
K	895	55.0	856	42.6	863	58.3	978	52.2
Mg	72.9^{A}	3.6	57.1^{B}	2.8	65.7	3.9	65.9	3.5
Na	474^{A}	32.9	357^{Bb}	25.5	453^{a}	34.9	490^{A}	31.3
P	512^{a}	32.3	424^{b}	25.0	465	34.2	496	30.6
S	16.0^{A}	0.88	12.6^{Bb}	0.83	15.6^{a}	0.93	15.5^{a}	0.68

$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

Table 4. Least squares means (LSM) and their standard errors (SE) for macroelements content of hair (μg/g)

Macro-element	Farm I		Farm II		Farm III		Farm IV	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Ca	474	68.9	648^{b}	65.4	443^{a}	73.1	609	53.4
K	3649^{A}	240	1497^{C}	186	497^{B}	255	1636^{C}	228
Mg	94.1^{A}	8.9	60.2^{B}	6.9	52.3^{B}	9.4	75.9	8.4
Na	748^{Aa}	53.2	379^{AB}	41.2	96.2^{B}	56.4	568^{Ab}	50.5
P	63.4^{Aa}	8.3	26.1^{B}	6.4	66.8^{A}	8.8	33.9^{Bb}	7.8
S	3888	235	4165	182	3752	250	3846	223

$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

significantly lower concentration of Mg in milk compared with TMR-fed cows. The levels of Ca, Mg and P in milk were generally lower compared to values reported by Kunachowicz *et al*. [2005]. Concentration of K in milk was similar in all groups, while content of K in hair was highest in farm I and lowest in farm III cows. Grass silages from areas with intensive livestock production and fertilized with slurry are generally high in potassium. High K content of the ration is considered an important risk factor in the development of hypomagnesaemia in cows [Schonewille *et al*. 1999]. Disorders of calcium, phosphorus and magnesium homeostasis in ruminants provide natural models for the study of the physiology and pathophysiology of these minerals. The knowledge that can be acquired with a better understanding of the pathogenesis of these disorders could give useful clues in puzzle of human osteoporosis [Riond *et al*. 1995].

No significant differences in B, Co, Cr, Cu, Fe and Ni content of milk were identified among the farms (Tab. 5). The lowest levels of Ba, Ge, Mn, Sn, Sr, V and Zn were observed in milk of cows from farm II, and of I, Li and Se from farm IV. The highest concentrations of I, Mn, Sr, V, Zn were found in farm I, of Li, Si and Sn in farm III, and of Ba and Ge in farm IV. Concentrations reported in the literature for cow's milk are (mg/l): 3.3 for Zn, 0.559 for I, 217.2 for Ba, 0.079 for Cu, 84.9 for Cr, 74.3 for Mn, 84.5 for V, 61.0 for Ni, 60.5 for Se, 28.2 for Ge, 11.5 for Mo, and 6.5 for Co [Dobrzański *et al*. 2005]. Other authors reported the following trace elements content

Table 5. Least squares means (LSM) and their standard errors (SE) for microelements content of milk

Micro-element	Farm I		Farm II		Farm III		Farm IV	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
B (µg/l)	96.6	9.7	90.7	7.5	85.0	10.3	96.0	9.2
Ba (µg/l)	23.3^{Aa}	6.8	4.0^{Ab}	5.3	27.5^{Aa}	7.2	59.0^{B}	6.4
Co (µg/l)	1.44	0.17	1.13	0.13	1.50	0.18	1.15	0.16
Cr (µg/l)	13.3	3.6	12.7	2.8	17.5	3.8	19.0	3.4
Cu (mg/l)	0.139	0.058	0.220	0.045	0.131	0.062	0.085	0.055
Fe (mg/l)	0.522	0.206	0.308	0.160	0.588	0.219	0.810	0.195
Ge (µg/l)	12.9	2.1	12.3^{b}	1.6	12.7	2.2	18.0^{a}	2.0
I (mg/l)	0.384^{a}	0.030	0.308	0.029	0.344	0.032	0.283^{b}	0.024
Li (µg/l)	58.9	11.7	55.3	9.1	81.3^{a}	12.4	47.0^{b}	11.1
Mn (µg/l)	31.1^{A}	1.6	22.0^{Bb}	1.2	27.5^{a}	1.7	22.0^{Bb}	1.5
Mo (µg/l)	76.7^{a}	6.1	92.7^{b}	4.7	82.5	6.5	77.0^{a}	5.8
Ni (µg/l)	45.6	1.4	43.2	1.1	45.3	1.5	43.2	1.3
Se (µg/l)	19.0	0.42	19.3^{b}	0.32	18.8	0.44	18.1^{a}	0.39
Si (µg/l)	55.6^{a}	15.9	92.0	12.4	107.5^{b}	16.9	73.0	15.1
Sn (µg/l)	14.9^{a}	0.84	12.3^{Bb}	0.65	15.4^{A}	0.89	15.1^{A}	0.80
Sr (mg/l)	0.202^{Aa}	0.012	0.112^{Ba}	0.009	0.141^{B}	0.012	0.166^{b}	0.011
V (µg/l)	20.0^{a}	1.5	15.7^{b}	1.2	18.0	1.6	15.0^{b}	1.5
Zn (mg/l)	1.97^{a}	0.147	1.57^{b}	0.114	1.76	0.156	1.49^{b}	0.139

$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – $P \leq 0.05$; capitals – $P \leq 0.01$.

of cow's milk: 300-600 μg/l Fe, 2-6 mg/l Zn, 0.1-0.6 mg/l Cu, 20-50 μg/l Mn, 0.26 mg/l I, 5-67 μg/l Se, 0.5-1.3 μg/l Co, 8-13 μg/l Cr, 18-120 μg/l Mo, 0-50 μg/l Ni, Si 750- 7000 μg/l Si and 0-310 μg/l V [Goff 1995]. Differences in the concentrations of major and trace elements in milk of cows depended on nutrition, breed, age, lactation period and performance, geographical location, place of experiment, production system, mineral status of cows and animal welfare.

The contents of trace elements in hair are shown in Table 6. No significant differences for Mn, Ni, Si, Sn, and Sr were identified between farms. The lowest contents of B, Ge, I, Se, Sn, V and Zn were shown in farm III, and of Co, Cr, Fe in farm I. The highest concentrations of B, Be, Co, Fe, Ge, Li were found in cow hair from farm IV, and of Cr, I, Mo, Se, Sn, Sr, V and Zn from farm II. According to Puls [1994] the reference dry matter concentrations in cow's hair are for example 0.1-2.5% for Ca, 130-455 ppm for Mg, 0.2 ppm for Cr, 6.7-32 ppm for Cu, 59-200 ppm for Fe, 0.5-1.32 ppm for Mn, 0.5-1.32 ppm for Se and 100-150 ppm for Zn. Determination of certain elements in hair may be useful for long term monitoring of mineral status of animals [Puls 1994].

Table 6. Least squares means (LSM) and their standard errors (SE) for microelements content of hair

Micro-elements	Farm I		Farm II		Farm III		Farm IV	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
B (μg/g)	1.20^{A}	0.16	0.64^{B}	0.12	0.53^{B}	0.17	1.29^{A}	0.15
Ba (μg/g)	0.157^{A}	0.064	0.092^{A}	0.060	0.451^{B}	0.067	0.487^{B}	0.049
Co (ng/g)	14.9^{Aa}	11.3	48.3^{Ab}	8.8	33.1^{A}	12.0	95.2^{B}	10.7
Cr (ng/g)	46.7^{a}	14.7	92.6^{b}	11.4	47.5^{a}	15.6	73.0	13.9
Cu (μg/g)	2.87^{a}	0.23	2.44	0.18	2.45	0.25	2.02^{b}	0.22
Fe (μg/g)	4.04^{Aa}	2.95	13.11^{Ab}	2.29	9.08^{A}	3.13	25.63^{B}	2.8
Ge (ng/g)	38.6^{A}	3.2	37.3^{A}	2.5	36.6^{A}	3.4	52.0^{B}	3.1
I (μg/g)	6.22^{A}	1.52	13.52^{B}	1.18	4.21^{A}	1.61	8.40^{A}	1.44
Li (ng/g)	4.06^{Aa}	2.1	9.98^{Ab}	1.6	6.79^{A}	2.1	18.7^{B}	2.0
Mn (μg/g)	3.80	0.33	3.87	0.26	3.37	0.35	3.33	0.32
Mo (ng/g)	103.3^{A}	37.4	370.7^{B}	29.0	67.5^{A}	39.7	64.0^{A}	35.5
Ni (ng/g)	64.3	3.6	67.2	2.8	68.7	3.9	73.4	3.5
Se (μg/g)	0.852	0.080	0.982^{b}	0.062	0.743^{a}	0.084	0.944	0.076
Si (μg/g)	5.45	0.37	5.29	0.29	4.50	0.39	5.17	0.35
Sn (μg/g)	0.133	0.010	0.141	0.008	0.128	0.010	0.128	0.009
Sr (μg/g)	0.544	0.069	0.640	0.053	0.593	0.073	0.529	0.065
V (ng/g)	25.7^{A}	5.3	51.5^{Ba}	4.1	17.2^{Aa}	5.6	34.3^{b}	5.0
Zn (μg/g)	25.3^{A}	5.2	51.1^{B}	4.0	17.0^{Aa}	5.5	33.8^{Ab}	4.9

[aA...]Within rows means bearing different superscripts differ significantly at: small letters – $P \leq 0.05$; capitals – $P \leq 0.01$.

Milk yield may affect the mineral status of cows. Due to intensive feeding, milk yield was significantly higher in farm I compared to the remaining herds. Differences were highly significant in both the daily milk yield and daily fat-corrected milk (FCM) yield (figures not shown). Main problem in pasture feeding is that composition and digestibility of nutrients, also contents of mineral elements, are highly affected by the stage of plant growth and can vary significantly in relatively short periods. Eventually, it is difficult to maintain constantly high milk production based on pasture feeding, even when quality of grass is high and soil and water conditions are suitable for grass production. Preliminary analyses showed no breed, parity and milk yield to affect the content of minerals of milk and hair of cows.

A change of body condition is a common physiological phenomenon in dairy cows. Usually condition worsens after parturition and then is gradually regained, what is more visible in the later part of lactation and during the dry period. This can also be related to cows' mineral supply. Clear difference among production systems was observed in cow's herd lifespan. The period from first calving to disposal (culling) was around 2.5 years in the intensive herd (farm I), while in the extensive herds it was two times longer (figures not shown).

The toxic elements of milk and hair are presented in Tables 7 and 8. The highest Cd and Pb ($P \leq 0.01$) contents of milk were found on farm II, the significantly highest Al content of hair on farm III, and significantly lowest content of Hg on farm I. No significant differences were found between farms for concentration of Al and As in

Table 7. Least squares means (LSM) and their standard errors (SE) for toxic elements content of milk (μg/l)

Elements	Farm I		Farm II		Farm III		Farm IV	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Al	55.6	18.0	75.3	14.0	57.5	19.1	51.0	17.1
As	12.8	1.2	10.2	0.9	12.8	1.2	15.0	1.1
Cd	1.11^{Aa}	0.03	12.5^{B}	0.03	1.06^{A}	0.03	1.00^{Ab}	0.03
Hg	0.56^{Aa}	0.05	0.03^{B}	0.04	0.68^{A}	0.05	0.73^{Ab}	0.04
Pb	5.22^{A}	0.67	7.93^{B}	0.52	4.13^{A}	0.72	5.30^{A}	0.64

[aA...]Within rows means bearing different superscripts differ significantly at: small letters – $P \leq 0.05$; capitals – $P \leq 0.01$.

Table 8. Least squares means (LSM) and their standard errors (SE) for toxic elements content of hair

Macro-elements	Farm I		Farm II		Farm III		Farm IV	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Al (μg/g)	5.72^{A}	1.40	13.39^{Bb}	1.08	17.46^{Ba}	1.48	12.89^{Bb}	1.33
As (ng/g)	33.2	2.8	32.1	2.2	35.1	3.0	39.7	2.7
Cd (ng/g)	2.72	0.09	2.70	0.07	2.75	0.10	2.68	0.09
Hg (ng/g)	25.3^{Aa}	15.0	68.1^{Ab}	11.6	48.3^{A}	16.0	132.4^{B}	14.3
Pb (ng/g)	79.8^{a}	19.8	41.3	15.4	17.1^{b}	21.1	32.1	18.8

[aA...]Within rows means bearing different superscripts differ significantly at: small letters – $P \leq 0.05$; capitals – $P \leq 0.01$.

milk, and As and Cd in hair. The contents of toxic elements in milk were low and below the admissible level [Disposition of the Minister of Health 2003]. The lowest Al content ($P \leq 0.01$) of hair was found in cows from conventional farm I, where no pasture was used at all. It is known that plants on acid soils intensively absorb Al. Thus, it is likely that grazing cows may take more dietary Al. Mineral concentration of plants generally reflects the efficiency of the soil to supply the element available to the roots. Plants react to inadequate supplies of available minerals in the soil by limiting their growth, reducing the concentration of the deficient elements in their tissues or, more commonly, reducing growth and tissue concentration simultaneously. Minerals uptake by plants and hence their mineral composition are greatly influenced by soil pH. Herbage contamination with soil or dust can at times provide a further significant source of minerals to grazing animals, especially when grazing intensity is high or when pasture availability is low. Soil intake can constitute 10-25% of total dry matter intake by out-wintered sheep and cattle [Underwood and Suttle 1999]. Significant amount of minerals can enter farm system from the atmosphere. Contamination with dust and fumes from industrial sources and dispersal of wastes from mining activities can also pose a further hazard to livestock.

This study demonstrated that the lower contents of mineral components of cow milk and hair under extensive farming system could reflect their deficiency in soil, and in consequence in green forage. The content of heavy metals in milk and hair depends on feed, their content of soil, environment contamination as well as the antagonistic bioelements x heavy metals interaction, affecting their absorption and metabolism. For these reasons the contents of toxic elements of milk from ecological farms were not found lower than of milk from conventional herds. The results presented suggest that the mineral composition of milk and hair depended on production system. It seems that the wider investigations of mineral composition of cow's hair could be useful for settlement of reference value for some elements. Study of method of quick diagnosing the deficiency of some mineral elements in animals would make a contribution to better animals' welfare.

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Zawartość makro- i mikroelementów w mleku i włosach krów z gospodarstw konwencjonalnych i ekologicznych

S t r e s z c z e n ie

Celem badań było stwierdzenie, czy różne systemy (intensywność) produkcji wpływają na zawartość składników mineralnych w mleku i we włosach krów. Do badań wybrano cztery stada bydła mlecznego, utrzymywane w czterech gospodarstwach. Dwa z nich to certyfikowane gospodarstwa ekologiczne, dwa pozostałe to gospodarstwa konwencjonalne, z których jedno charakteryzowało się intensywnym systemem produkcji, a drugie systemem ekstensywnym i zbliżone było do gospodarstw ekologicznych. We wszystkich czterech gospodarstwach obserwacjami objęto po 10 krów rasy polskiej holsztyńsko-fryzyjskiej (hf), a w gospodarstwie konwencjonalnym ekstensywnym dodatkowo 10 krów rasy polskiej czerwonej (pc). Próbki mleka i włosów do oznaczenia składników mineralnych pobrano jednorazowo we wrześniu. Włosy pobrano z wału międzyrożnego. W mleku i włosach oznaczono zawartość Ca, K, Mg, Na, P, S, B, Ba, Co, Cr, Cu, Fe, Ge, I, Li, Mn, Mo, Ni, Se, Si, Sn, Sr, V, Zn, Al, As, Cd, Hg i Pb. Średnia koncentracja Ca, Mg i P w mleku była najwyższa w gospodarstwie konwencjonalnym (bez dostępu do pastwiska), w porównaniu z gospodarstwami, w których krowy korzystały z pastwiska. Najwyższą zawartość I, Mn, Sr, V i Zn w mleku stwierdzono w gospodarstwie konwencjonalnym z intensywnym systemem produkcji. Najwięcej Li, Si, Sn, Ba i Ge zawierało mleko z gospodarstw ekologicznych. Najwyższą zawartość B, Be, Co, Fe, Ge i Li we włosach krów stwierdzono w gospodarstwie ekologicznym, a najwyższą zawartość Cr, I, Mo, Se, Sn, Sr, V i Zn w gospodarstwie konwencjonalnym o ekstensywnej produkcji. Najwięcej Cd i Pb zawierało mleko z gospodarstwa konwencjonalnego o ekstensywnej produkcji. Nie udowodniono znaczących różnic między gospodarstwami w koncentracji Al i As w mleku ani As i Cd we włosach. Poziomy elementów toksycznych w mleku okazały się niskie i leżały poniżej wartości dopuszczalnych. Uzyskane wyniki sugerują, że skład mineralny mleka i włosów zależał od systemu produkcji.