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The Influence of a Mineral Mixture on the Level of Selected Macroelements in Dairy Cows from the Region of Southern Podlasie

Wpływ dodatku mieszanki mineralnej na poziom wybranych makroelementów u krów mlecznych z rejonu południowego Podlasia

Achieving higher productivity of dairy cows involves satisfying the animal protein-energy requirements as a well as balanced supply of mineral elements [15]. While feeding animals on fodder with inappropriate balance and the insufficient amount of mineral elements might lead to breeding disorders, decrease in productivity and lower concentration of mineral elements in animal organisms [16]. The missing elements could be supplied directly in water, mineral licks, mixtures and drenches, rumen preparations (heavy pellets, soluble glass pellets), and intramuscular injections [10]. It is important to remember that the composition of these complements should be based on a previous study of research into biogeochemical conditions of farm location [2].

In the previous research [6], the mineral balance of dairy cattle was evaluated, through the examination of the trophic scheme: soil-fodder-body tissue. The research revealed a phosphorus and magnesium deficiency in each element of the trophic scheme. Taking into consideration the geobiochemical conditions of the farm location, the composition of the mineral mixture was worked out.

The aim of the research was to evaluate the usefulness of the mineral mixture Bovifosfomag® for dairy cattle in the area of southern Podlasie, and to study its effect on the concentration of certain macroelements in blood serum of animals.

MATERIAL AND METHODS

The two-year research was carried out on 4 dairy farms „A", „B", „C" and „D" situated in the area of southern Podlasie. The herds including 12 cows of Black-and-White breed, were divided into 2 groups: control group (K) and experimental group (D). Their average productivity 3.3 thousand litres of milk. The cows in control groups were not supplemented with the mineral mixture. The cows in experimental groups received the mineral mixture Bovifosfomag®, whose composition was based on the previous research into mineral deficiency of cows in southern Podlasie [6]. Its daily dose amounted to 150g per cow. The mixture was gradually introduced to animal dietary units in the morning meal, in the period of 14 days. During the research the animals were kept in the same conditions. In summer the animals were fed on green grass, supplemented with meadow hay and barley straw. In winter they were supplied with corn silage and meadow hay, with the addition of barley straw.

Tab. 1. Material composition of experimental Bovifosfomag® mixture

Source compound (macroelements)	Content of pure element (g)				
	(g)	Ca	P	Mg	Na
Calcium phosphate $Ca(H_2PO_4)_2$	350	60	95	-	-
Tricalcium phosphate $Ca_3(PO_4)2$	100	39	20	-	-
Magnesium oxide MgO	175	-	-	105	-
Ground limestone $CaCO_3$	200	80	-	-	-
Forage salt NaCl	175	-	-	-	70
Total	1000	179	115	105	70

Source compound (microelements)	Content of pure element (g)							
	(g)	Zn	Cu	Fe	Mn	Se	I	Co
		(g)			(mg)			
Zinc sulfate $ZnSO_4$ $7H_2O$	22.000	5.0	-	-	-	-	-	-
Cupric sulfate $CuSO_4$ $5H_2O$	4.000	-	1.0	-	-	-	-	-
Ferrous sulfate $FeSO_4$ $7H_2O$	5.000	-	-	1.2	-	-	-	-
Manganese carbonate $MnCO_3$	0.020	-	-	-	10.0	-	-	-
Sodium selenate Na_2SeO_4	0.050	-	-	-	-	20.0	-	-
Potassium iodide KI	0.040	-	-	-	-	-	30.0	-
Cobalt sulfate $CoSO_4$ $7H_2O$	0.015	-	-	-	-	-	-	3.0
Total	31.125	5.0	1.0	1.2	10.0	20.0	30.0	3.0

The feeding was supplemented with farm produced concentrate according to productivity. Dietary requirements of cows were determined according to the Standards for Animal Feeding [11]. The material for a detailed research was acquired in the second year of using the mineral mixture, after a detailed medical-veterinary check up. Whole blood was sampled 4 times: at the beginning of drying-off period (about 60 days before breeding), 10–14 days before breeding, after the first and second months of lactation. The concentration of Ca, Mg, Na and K in blood serum was determined with flame spectrophotometer ASA – Unicam 939, and the amount of inorganic phosphorus according to Fiske-Subbarow's method with colorimeter Roche/Hitachi 704. Inorganic phosphate forms an ammonium phosphomolybdate complex having the formula $(NH_4)_3[PO_4(MoO_3)_{12}]$ with ammonium molybdate in the presence of sulfuric acid. The complex is determined photometrically in the ultraviolet region (340 nm) [4]. The numerical data were analysed statistically using Microsoft® Excel 2000 and Statistica 5, Version 97 software. Mean values were compared by means of Student's test.

DISCUSSION

Figures 1–5 reflect the concentration of certain macroelements in blood serum of cows on farms „A", „B", „C" and „D".

Taking into account the data from experimental and control groups received in each herd, the mixture usage had an effect on the concentration of the studied elements in blood serum of cows. Ca concentration in blood serum of cows from control groups was at the lowest level of the optimum value [17]. In experimental groups the addition of mineral mixture led to an increase in Ca concentration, though the upper level of physiological norm was not exceeded (Fig. 1). It could show high homeostatic controls involved in the regulation of Ca level in blood serum, and it is the result of hormone and biologically active cells control [1]. The increase in Ca concentration in blood serum of cows receiving mineral mixture was also observed by Goff and Horst [5]. However Saba [13] observed a decrease in Ca concentration after the usage of mineral mixture.

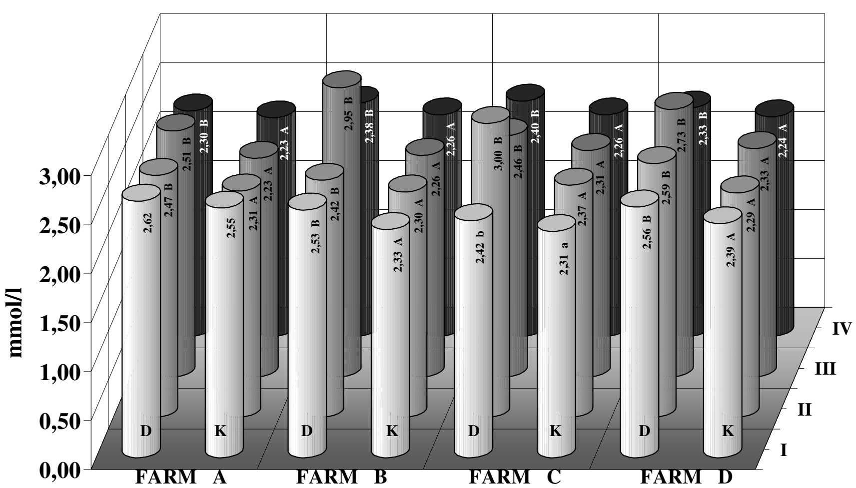

Fig. 1. Average amount of Ca in blood serum of cows taking into account experimental group and date of sampling; K – control group, D – experimental group, I, II, III, IV – samplings
$^{A,\,B}$Significant at $p \leq 0.01$; $^{a,\,b}$Significant at $p \leq 0.05$

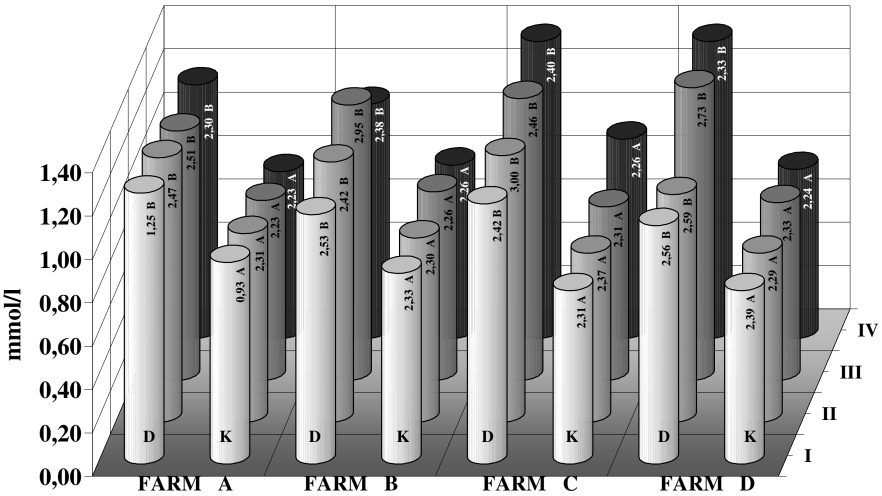

Fig. 2. Average amount of P in blood serum of cows taking into account experimental group and date of sampling; K – control group, D – experimental group, I, II, III, IV – samplings, $^{A, B}$Significant at $p \leq 0.01$

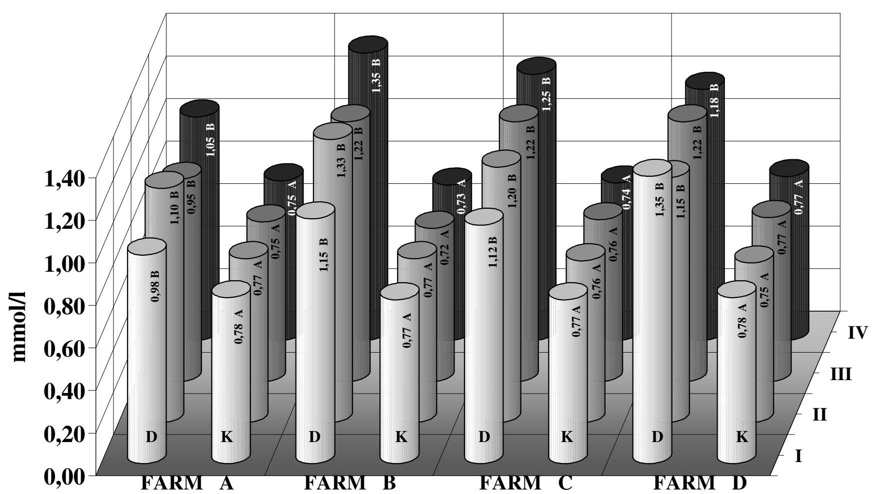

Fig. 3. Average amount of Mg in blood serum of cows taking into account experimental group and date of sampling; K – control group, D – experimental group, I, II, III, IV – samplings, $^{A, B}$Significant at $p \leq 0.01$

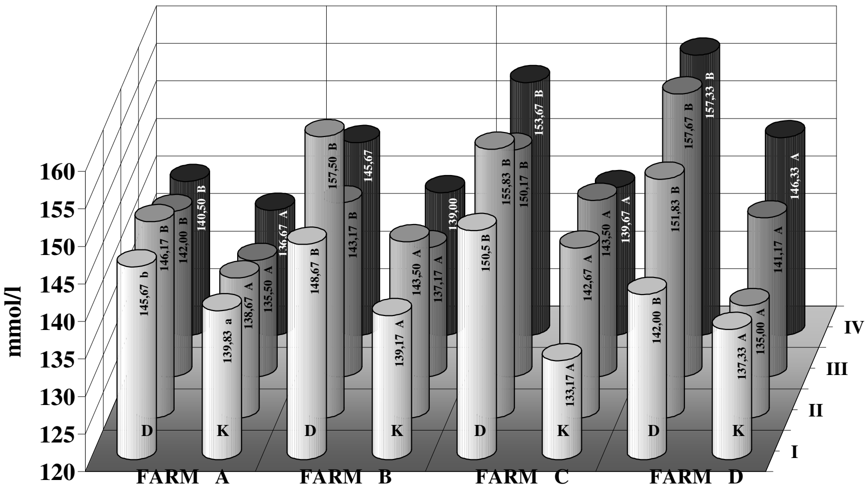

Fig. 4. Average amount of Na in blood serum of cows taking into account experimental group and date of sampling; K – control group, D – experimental group, I, II, III, IV – samplings
$^{A, B}$ Significant at p≤0.01, $^{a, b}$ Significant at p ≤0.05

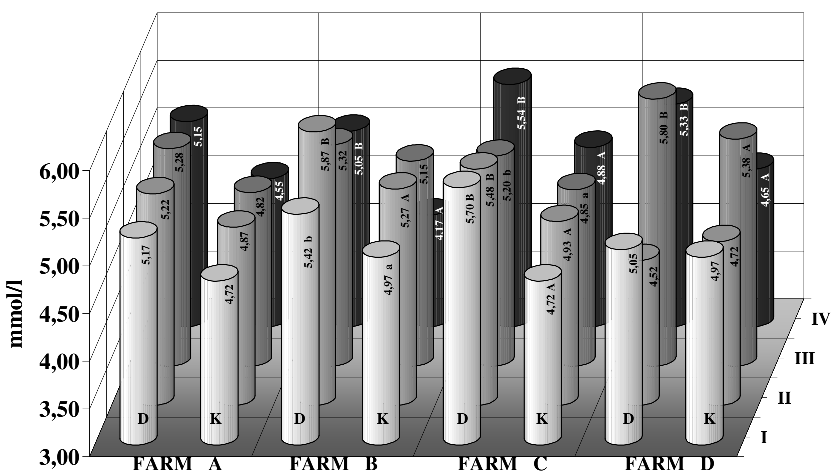

Fig. 5. Average amount of K in blood serum of cows taking into account experimental group and date of sampling; K – control group, D – experimental group, I, II, III, IV – samplings
^{A,B} Significant at p≤0.01, $^{a, b}$ Significant at p≤0.05

Statistically significant differences in the concentration of inorganic phosphorus were observed between the experimental and control groups (Fig. 2). The content of inorganic phosphorus in control groups on all 4 farms was below the physiological standard and amounted to 1.0 mmol/l [17]. Phosphorus deficiency in blood serum of cows from control groups was caused by feeding animals on fodder containing insufficient amounts of this element. Similar observations are found in Kruczyńska and Mocek's work [9]. The concentration of inorganic phosphorus in blood serum of cows from control groups was close to the values received by Wnuk at al. [18], but somewhat lower than the values in Dymnicka's research [3]. After the usage of mineral mixtures a statistically significant increase in the amount of phosphorus ($p \leq 0.01$) in blood serum of cows was observed. A beneficial influence of mineral mixture on P concentration was also observed by Knowlton and Herbein [8]. In the experimental groups P concentration did not exceed 1.37 mmol/l. Not very high P concentration in blood serum of cows might be the result of homeostatic control of P content in the animal organism. The usage of mineral additives containing phosphate, improved the calcium-phosphorus ratio. Similar results were also acquired by Ostergaard and Larsen [12].

Before the mineral mixture was supplied, Mg level in blood serum of cows was below, or at the lowest level of physiological value (0.78-1.23 mmol/l) [17]. An especially low Mg concentration was registered in III and IV samplings. After the usage of mineral additives, a statistically significant increase of this element was observed in the experimental groups in each herd (Fig. 3). Mg concentration reached the highest level of physiological value and even exceeded it in case of cows on farms B and D. Satisfying the animal requirements for magnesium depends on its concentration in fodder, its assimilation from a dietary unit as well as its supply in mineral mixture and assimilation of additives. What is more, magnesium assimilation largely depends on potassium concentration in fodder. According to previous research, fodder on the analysed farms was characterized by a high amount of this element [6]. Therefore, it is possible to conclude that the reason for Mg deficiency was higher K concentration in fodder, and magnesium-potassium, interaction which hinders Mg assimilation. The advisability of using mineral mixture containing Mg was stated by Saba at al. [14].

Sodium concentration in blood serum of cows on some farms was within the physiological norm [17]. Only in the experimental groups II, III and IV samples, a slight excess of the upper level of physiological norm was observed. The main objective of adding forage salt to the mineral mixture was to improve Na:K ratio, taking into account high concentration of potassium in fodder. The supplement of a mineral mixture caused significant differences ($p \leq 0.01$) in Na concentration, to the advantage of the experimental groups (Fig. 4).

The research confirmed the observations of other authors concerning common occurrence of high potassium concentration in blood serum of dairy cattle. Differences in K amount between the animal groups did not reveal any regularity. Only in herd C statistically high significant differences in potassium concentration were observed in all samplings to the advantage of the experimental group (Fig. 5). The research carried out by Wnuk et al. [18] did not reveal changes in K concentration in blood serum after the addition of mineral mixture containing this element.

CONCLUSIONS

The experimental mixture Bovifosfomag®, worked out on the basis of previous research into the deficiency of macroelements, caused improvement in the mineral balance of cows on all the examined farms, and resulted in the increase of macroelements concentration in blood serum of cows.

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STRESZCZENIE

Badania trwające dwa lata przeprowadzono w czterech fermach bydła mlecznego „A”, „B”, „C” i „D”, zlokalizowanych na terenie południowego Podlasia. Krowy w każdym z gospodarstw podzielono na dwie grupy: kontrolną (K) i doświadczalną (D). Krowy z grup kontrolnych nie otrzymywały dodatku mieszanki mineralnej. Zwierzęta z grup doświadczalnych otrzymywały mieszankę mineralną Bovifosfomag®. Skład mieszanki uwzględniał warunki geobiochemiczne lokalizacji gospodarstw. W okresie badań oceniono przydatność mieszanki mineralnej na podstawie analizy koncentracji makroelementów (Ca, P, Mg, Na, K) w surowicy krwi krów. Wykazano korzystny wpływ mieszanki podawanej zwierzętom z grup doświadczalnych we wszystkich czterech fermach na gospodarkę mineralną, co wyrażało się wzrostem zawartości w surowicy krwi poziomu P nieorganicznego i Mg, czyli składników mineralnych, których stężenie w organizmie zwierząt w czasie badań monitoringowych było zbyt niskie.