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Contents of some minerals in the feed obtained from organic farming

Zawartość niektórych składników mineralnych w paszy pozyskanej z użytków ekologicznych

Summary. The research dealt with the analysis of selected minerals concentrations in a pasture sward originating from the organic farm, in the aspect of its usefulness for animal feeding. The plants were sampled twice during the vegetation season and subject to determinations of calcium (Ca), sodium (Na), potassium (K), magnesium (Mg), manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn) contents by means of atomic absorption spectrophotometry (AAS). Relatively low calcium and sodium, while high of zinc, copper, and iron concentrations were found in the analyzed plant material, which suggests the necessity of supplementing the animal's diet with deficit macronutrients.

Key words: ecological grasslands, pasture sward, minerals

INTRODUCTION

Permanent grasslands are commonly considered as a source of cheap and valuable fodder for farm animals. Their abundance in vitamins, minerals, and variety of compounds important for health and productivity makes that they are irreplaceable in organic farms or farms involved in producing the functional food. Many authors underline that they can successfully be a sufficient feed for ruminants [Goliński 2007, Jankowska-Huflejt and Romański 2008]. The role, they play in an environment protection, should be also mentioned. However, permanent grasslands are often utilized in extremely extensive manner, which substantially affects both their productive and environmental values. It is usually associated with the lack of any nutrition (namely on soils little abundant in general nutrients), uncontrolled water balance, or irregular mowing (or grazing), which can be a reason for disappearance of natural meadow ecosystems due to succession [Jankowska-Huflejt and Romański 2008, Mazur 2000]. It seems that positive changes in

management of permanent grasslands result from Polish accession in European Union and opportunities to achieve subsidies for agriculture and environment protection. Promoted directions for improving these fodder resources utilization relate mainly to develop of herbivorous animals maintenance, namely meat cattle and sheep, which is realized by organic farms [Goliński 2007, Jankowska-Huflejt and Romański 2008].

Many authors report that animal feeding based exclusively on fodders achieved from some areas may be a reason for minerals deficits, namely during their intensive growth or lactation. It is then necessary to apply mineral additives that would protect from negative effects of deficient feeding [Czuba 1994, Fałkowski *et al*. 2000, Khan *et al*. 2007, 2009].

The study aimed at analyzing the levels of some minerals in a meadow sward originating from ecological grasslands localized in Podkarpacie province taking into considerations the mowing date.

MATERIAL AND METHODS

Material for study consisted of plants occurring in the area under agricultural-environmental program realized in reference to semi-natural extensively utilized meadows. The study was carried out on permanent grasslands of 1.60 ha area situated in Podkarpacie province, in Zagórz commune. The grasslands in question are localized on brown, strongly acidified soils (4.3 pH_{KCl}) of three bonitation classes (III, IV, V). For scientific purposes, the meadow was divided into five parts taking into account their bonitation classifications (all quarters were uniform referring to botanical composition). Hay harvested from studied meadow was a fodder for sheep maintained in a farm.

Representative samples of meadow sward subject to determinations of selected minerals levels, were collected during the vegetation season directly before mowing (21.06 and 24.08 – quarters belonging to bonitation classes III and IV, as well as 21.06 – quarter from bonitation class V) by random cutting the plants from 1 m^2 area in 4 replicates. Samples were dried till constant weight, ground, digested, and then concentrations of calcium (Ca), sodium (Na), potassium (K), magnesium (Mg), manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn) were determined. Minerals were analyzed by means of atomic absorption spectrophotometry technique (AAS).

Determinations were performed in three subsequent years (2008, 2009, 2010). Achieved results were statistically processed using Statistica 7.0 software. The significance of differences was verified applying t-Student test.

RESULTS AND DISCUSSION

Contents of macronutrients and microelements in a green forage, as well as silage, hay, and dried products greatly depends on an abundance and acidity of a soil, as well as its fertilization. This fact is particularly important in the case of animal feeding using a fodder produced on ecological grassland areas, where deficits (or excess) of some minerals can occur due to the excessive soil acidification, or too low sorption capacity of poor soils at no liming or soil fertilization [Czuba 1994]. Disturbances in mineral balance of animal's organisms can be the effects [Haenlein and Anke 2011, Khan *et al*. 2009, Wieleba and Pasternak 2001].

Table 1. Forage minerals (mean ± SE) as related to years
Tabela 1. Minerały w paszy (średnia ± s) w zależności od roku

Year	Minerals (g kg^{-1} d.m.)				Minerals (mg kg^{-1} d.m.)			
	K	Ca	Mg	Na	Mn	Cu	Zn	Fe
2008	47.88 ± 19.66[a]	4.89 ± 2.12 [a]	4.06 ± 0.64	0.26 ± 0.05[a]	39.8 ± 4.71	25.66 ± 6.94	36.68 ± 6.76	98.48 ± 13.27
2009	48.28 ± 5.56 [b]	6.10 ±3.46 [b]	3.83 ± 0.54	0.28 ± 0.05[a]	40.82 ± 2.67 [a]	29.38 ± 5.13	38.48 ± 5.61	109.68 ± 12.19
2010	51.80 ± 5.87 [b]	5.96 ± 1.53 [a]	3.94 ± 0.22	0.31 ± 0,01[b]	45.94 ± 6.66 [b]	30.98 ± 2.27	32.94 ± 19.26	100.60 ± 12.88

a,b – values in the same columns with different letters differ significantly at $p \leq 0.05$
a, b – wartości w kolumnach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$

Table 2. Forage minerals (mean ± SE) as related to seasons
Tabela 2. Minerały w paszy (średnia ± s) w zależności od terminu pobierania próbek

Date Termin	Minerals (g kg^{-1} d.m.)				Minerals (mg kg^{-1} d.m.)			
	K	Ca	Mg	Na	Mn	Cu	Zn	Fe
1	47.53 ± 1.31	5.93 ± 0.57 [a]	3.92 ± 0.18 [a]	0.26 ± 0.05	38.83 ± 2.67 [a]	28.00 ± 5.43	38.20 ± 5.47	98.37 ± 11.27 [a]
2	36.61 ± 13.45	5.39 ± 1.45 [a]	3.51 ± 0.29 [a]	0.28 ± 0,03	39.53 ± 4.73 [a]	27.30 ± 6.09	36.17 ± 0.12	80.50 ± 13.59 [a]
3	49.49 ± 1.98	5.09 ± 1.13 [b]	4.45 ± 0.18 [b]	0.30 ± 0.03	42.70 ± 2.92 [a]	32.70 ± 1.75	34.80 ± 0.43	126.00 ± 19.66 [b]
4	60.45 ± 9.00	5.29 ± 2.24	3.53 ± 0.11	0.32 ± 0.02	47.40 ± 6.83 [b]	25.53 ± 5.47	39.53 ± 14.51	92.77 ± 19.29 [a]
5	52.86 ± 7.00	6.54 ± 0.79	4.31 ± 0.37	0.26 ± 0.04	42.47 ± 1.89 [b]	29.83 ± 1.32	31.47 ± 0.05	116.07 ± 13.84 [b]

1, 2, 3 – sampling date 21.06 – quarters of bonitation classes III, IV, and V
1, 2, 3 – termin pobierania próbek 21.06 – kwatery należące do klasy III, IV i V
4, 5 – sampling date 24.08 – quarters of bonitation classes III and IV
4, 5 – termin pobierania próbek 24.08 – kwatery należące do klasy III, IV
a, b – values in the same columns with different letters differ significantly at $p \leq 0.05$
a, b – wartości w kolumnach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$

Concentrations of analyzed minerals in examined fodder during subsequent years of the experiment are presented in Table 1. Statistically significant differences referring to potassium, calcium, sodium, and manganese in particular experimental years, were recorded, whereas magnesium, iron, copper, and zinc contents were at similar levels.

Concentrations of elements in studied meadow sward seemed to result mainly from the soil types, that were typical for the area of study. Woźniak [1996], who characterized the soils and plants of Bieszczady Mountains, reported that acidic brown soils are distinguished by low calcium and sodium concentrations at high levels of potassium contents. It was reflected in quantities of these minerals in the pasture sward, which in turn affected the animal's organisms supply. Research of other authors carried out upon the areas with specific soil compositions confirmed such a fact in a view of various minerals [Alberski *et al*. 2009, Khan *et al*. 2007, Omoregie and Oshineye 2002]. The improvement of produced fodder quality from the areas, where no intensive nutrition is applied can be also realized by means of keeping the optimum soil pH and organic fertilizers use [Mazur 2000].

Meeting the organism requirements of the animal fed exclusively with fodder produced on areas with deficits may be problematic, because macronutrient absorption (mainly Ca and Mg) usually does not exceed 50% and depends on a fodder composition, age and physiological status of an animal, as well as interactions between particular bioelements [Gabryszuk 1994]. According to Fałkowski *et al*. [2000], the optimum sodium content in a balanced feed should amount to 1.5 mg kg^{-1}.

Relatively high levels of zinc, copper, and iron in the meadow sward (Tab. 1 and 2) seems to be an effect of low soil pH and its type; the optimum for grasses ranges within pH 5 and pH 8, while that value was much lower on studied area. It is also worth mentioning that iron content in grass may vary from 60 up to 140 mg kg^{-1} [Kabata-Pendias and Pendias, 1993], whereas copper concentrations remarkably exceeds mean values for grasses, which can result from the abundance of mother rocks (forming the soils) in that element [Kabata-Pendias and Pendias 1993, Wall 2008].

Average contents of minerals in a fodder taking into considerations the pasture sward harvest as well as bonitation class of the soil, were also analyzed (Tab. 2). Statistically significant differences referring to calcium and magnesium concentrations (determined the same date) in plant material achieved from soils of bonitation classes III and IV vs. these elements percentage in the sward on soil of bonitation class V, were recorded. Manganese content was remarkably higher in samples collected later date.

CONCLUSIONS

Achieved results revealed that animal feeding exclusively with fodders produced in ecological farms can be risky, because of not meeting the animal's requirements for some elements. Therefore, it seems to be reasonable to complete the nutrition rate (by means of supplementation) with deficit minerals.

REFERENCES

Alberski J., Grzegorczyk S., Kozikowski A., Olszewska M., 2009. Habitat occurrence and nutrition value of *Achillea Millefolium L.* in grasslands. J. Elementol., 14 (3), 429–436.

Czuba R., 1994. Zawartość składników mineralnych w roślinach pastewnych w zależności od zasobności gleb. Konf. Naukowa: Związki mineralne w żywieniu zwierząt. 8–9 września 1994 Poznań, 35–39.

Falkowski M., Kukułka J., Kozłowski S., 2000. Właściwości chemiczne roślin łąkowych. Wyd. AR Poznań.

Gabryszuk M., 1994. Zapotrzebowanie owiec na składniki mineralne. Konf. Naukowa: Związki mineralne w żywieniu zwierząt. 8–9 września 1994, Poznań, 193–200.

Goliński P., 2007. Aktualne trendy w technologii produkcji roślinnych surowców paszowych. Konf. Nauk. Produkcja pasz objętościowych dla przeżuwaczy, 8–9 maja 2007, Puławy, 19–23.

Haenlein G.F.W., Anke M., 2011. Mineral and trace element research in goats: A review. Small Rum. Res. 95, 2–19.

Jankowska-Huflejt H., Romański P.J., 2008. Aktualne i możliwe kierunki wykorzystywania trwałych użytków zielonych w Polsce. Woda – Środowisko – Obszary Wiejskie, t. 8, 2b (24), 31–49.

Kabata-Pendias A., Pendias H., 1999. Biogeochemia pierwiastków śladowych. PWN, Warszawa.

Khan Z.I., Hussain A., Ashfar M., Ashraf M.Y., McDowell L.R., 2007. Macromineral status of grazing sheep in a semi-arid region of Pakistan. Small Rum. Res. 68, 279–284.

Khan Z.I., Ashfar M., Ahmad K., Valeem E.E., McDowell L.R., 2009. Mineral status of forage and its relationship with that of plasma of farm animals in southern Punjab, Pakistan. Pak. J. Bot., 41(1), 67–72.

Mazur T., 2000. Mikroelementy nawozów organicznych w nawożeniu zrównoważonym. Zesz. Prob. Post. Nauk. Rol., 471, 847–853.

Omoregie A.U., Oshineye A.A., 2002. Mineral contents and their relationships in soil-forage system along a transhumant route of nomadic pastoralists in southern Nigeria. Commun. Soil Sci. Plant Anal., 33 (11&12), 1841–1851.

Wall Ł., 2008. Zawartość mikroelementów w runi łąkowej z terenów Dolnego Śląska o wysokiej zawartości metali ciężkich. Zesz. Nauk. UP Wroc., Rol., 93, 569, 7–13.

Wieleba E., Pasternak K., 2001. Pierwiastki śladowe w systemie antyoksydacyjnym zwierząt. Med. Wet., 11, 788–791.

Woźniak L., 1996. Biogenne pierwiastki metaliczne i niektóre toksyczne metale ciężkie w glebach i roślinach Bieszczadów. Zesz. Nauk. AR w Krakowie, Rozprawy, 216.

Streszczenie. Badania dotyczyły analizy stężenia wybranych minerałów z runi łąkowej pochodzącej z terenu gospodarstwa ekologicznego w aspekcie jej przydatności do żywienia zwierząt. Roślinność pobierano dwukrotnie podczas sezonu wegetacyjnego i oznaczono poziom wapnia (Ca), sodu (Na), potasu (K), magnezu (Mg), manganu (Mn), żelaza (Fe), miedzi (Cu) i cynku (Zn) metodą absorpcyjnej spektrometrii atomowej (ASA). Stwierdzono stosunkowo niską zawartość wapnia i sodu oraz wysoką cynku, miedzi i żelaza w analizowanym materiale roślinnym, co sugeruje konieczność uzupełniania dawki pokarmowej żywionych nim zwierząt o deficytowe makroelementy.

Słowa kluczowe: użytki ekologiczne, ruń łąkowa, minerały