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ESTIMATION OF THE QUALITY AND NUTRITIONAL VALUE OF HAY FROM THE SELECTED INDIVIDUAL FARMS LOCATED IN THE REGION OF KRAKOW-CZESTOCHOWA JURA PART II. CONTENT OF MACROELEMENTS

OCENA JAKOŚCI I WARTOŚCI POKARMOWEJ SIANA Z WYBRANYCH GOSPODARSTW INDYWIDUALNYCH POŁOŻONYCH NA TERENIE JURY KRAKOWSKO-CZĘSTOCHOWSKIEJ CZ. II. ZAWARTOŚĆ MAKROELEMENTÓW

Abstract: This paper presents an estimation of the mineral composition of the hay derived from the selected farms specialized in milk production from the region of the Krakow-Czestochowa Jura. The samples of hay, four from each farm, were collected for the chemical analysis before grazing. Phosphorus and magnesium content was determined by the colorimetric vanadium-molybdenic method, whereas potassium, sodium and calcium using flame photometry.

The weighted mean content of macroelements in plants fluctuated in the range of: 1.09–2.59 g P; 14.03–24.06 g K; 3.86–6.10 g Ca; 1.71–3.33 g Mg; 0.41–1.14 g Na · kg^{-1} d.m. All samples collected during the experiment were characterized with low phosphorus, calcium and sodium content. The low level of these elements resulted from the low level of phosphorus fertilization and limited liming of the grasslands located in the area of examined farms. Among all elements only the level of potassium content was optimal. Conducted analyses suggest that grasslands located in the investigated farms are fertilized with liquid manure, what leads to accumulation of potassium, which is a calcium and magnesium antagonist.

Keywords: hay, content of macroelements, antagonism of elements

Hay, which was in recent times the main element of winter feeding for cows, now is more often replaced with silages and haylages. However, complete replacement is considered as a feeding misconception, especially in the case of ruminants, because hay has a positive effect on the fermentation processes in the rumen as well as digesta pH reaction [1]. Moreover, hay of good quality provides many nutrients, mineral com-

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pounds and vitamins to animals, which helps, in a natural way, in prevention of metabolic diseases [2]. Especially valuable from a nutritional point of view is the meadow hay composed of valuable grasses, legumes and herbs, which affect the flavor and palatability of the forage, which in turn triggers a higher degree of its consumption [3–5]. Hay should contain at least: 3.0 g P; 17–20 g K; 7.0 g Ca; 2.0 g Mg and 1.5–2.5 g Na · kg^{-1} in dry matter. Providing the proper amounts of mineral compounds is especially important in the case of milk cows, because for the production of 1 liter of milk the balanced forage as regards not only the energy and protein aspect but also containing enough levels of macro- and microelements is required [2].

Thus, the aim of the present study was an estimation of the mineral composition of hay derived from the selected farms specialized in milk production from the region of the Krakow-Czestochowa Jura.

Materials and methods

The investigations were conducted in the years 2005–2007 in 12 farms specialized in milk production located in the region of Krakow-Czestochowa Jura. The investigated farms were located in the Pilica administrative districts (Zawiercie county, Silesia province) at the altitude of 320 m. The experimental grasslands were located on the brown, acid soils and on the podsolic soils. The soils were classified from IVb to VI bonitation class. The soil was characterized with the pH_{KCl} acidity of 4.5–5.5 (acid and very acid), medium content of assimilable potassium and a low level of assimilable phosphorus and magnesium.

During the vegetation period (April–September) the following average rainfall amounts were determined for the years 2005, 2006 and 2007: 356.8 mm; 338.1 mm; and 375.4. The mean temperatures for the following years amounted to: 14.8, 15.2 and 14.3 ^{o}C.

The experimental hay was derived mostly from the first and second regrowth of grass flora and in a minor amount from the third regrowth.

The plants were collected at the turn of the heading and flowering stage – the first regrowth and during the heading stage – the second and the third regrowths. Before the feeding the 4 samples of hay were collected from each farm and subjected to the chemical analysis, which comprised: the estimation of phosphorus and magnesium content – by the colorimetric vanadium-molybdenic method, potassium, sodium and calcium – by the flame photometry method.

The results presented in this paper were limited to the mean values for the following years. The obtained results were subjected to the analysis of variance and the significance of differences was estimated using the Duncan test at the significance level of $\alpha = 0.05$.

Results and discussion

The content of mineral components in the investigated hay samples was diversified. The weighted mean content of macroelements fluctuated in the range of: 1.09–2.59 g P;

Table 1

The weighted mean content of macroelements and the ionic proportions in hay

Item	Investigated farm											
	1	2	3	4	5	6	7	8	9	10	11	12
	$g \cdot kg^{-1}$ d.m.											
P content [g kg^{-1} d.m.]	1.53ab*	2.27b	2.46c	2.57c	1.91b	2.44c	2.45c	2.59c	1.09a	1.83b	1.74b	1.62ab
K content [g kg^{-1} d.m.]	23.44c	18.31b	19.65b	17.93b	24.06c	18.01b	15.85a	16.83ab	14.88a	14.03a	17.24ab	15.45a
Ca content [g kg^{-1} d.m.]	5.82bc	5.28b	4.85ab	4.42ab	5.94c	6.10c	3.91a	4.22a	3.88a	3.86a	4.33a	4.03a
Mg content [g kg^{-1} d.m.]	1.71a	2.26b	2.38b	1.82a	2.27b	3.33c	2.10ab	2.44b	2.42b	1.93a	3.08c	2.63cb
Na content [g kg^{-1} d.m.]	0.46a	0.60ab	0.71b	0.59ab	0.49a	1.14c	0.41a	0.52a	0.62ab	0.48a	0.60ab	0.56ab
Ca:Mg	3.39c	2.34bc	2.04b	2.43bc	2.62bc	1.83ab	1.86ab	1.73ab	1.60a	2.00b	1.41a	1.53a
K:Mg	4.28d	2.54b	2.59b	3.08c	3.32c	1.69a	2.36b	2.16ab	1.92a	2.27ab	1.75a	1.84a
K:Ca	2.06b	1.78a	2.08b	2.08b	2.08b	1.51a	2.08b	2.04b	1.97ab	1.86ab	2.04b	1.97ab
K:(Ca + Mg)	1.39c	1.04ab	1.15b	1.24b	1.27b	0.80a	1.10ab	1.05ab	0.97a	1.02ab	0.94a	0.95a
K:Na	51.33d	30.30b	27.68b	30.31b	49.57d	15.87a	38.84c	32.42b	24.14a	28.93ab	28.81ab	27.57ab

* Means marked with the same letter are not statistically different following verification with the Duncan test ($p = 0.05$).

14.03–24.06 g K; 3.86–6.10 g Ca; 1.71–3.33 g Mg; 0.41–1.14 g Na · kg^{-1} d.m. (Table 1). According to the feeding requirements the good quality forage should contain at least 3.0 g P; 17–20 g K; 7.0 g Ca; 2.0 g Mg and 1.5–2.5 g Na · kg^{-1} in dry matter [5–7]. In our study we noticed that respectively 75 % and 58 % of samples were characterized with optimal magnesium and potassium content. On the contrary, phosphorus, calcium and sodium concentrations in all samples were below the optimal levels.

For evaluation of the forage quality the quantitative or ionic proportions between elements are important [6–8]. The Ca:Mg weight ratio, which should be equal to 2–3:1, was optimal only in 42 % of samples, whereas none of them was characterized with the proper K:Mg weight proportion, which should be close to 6–8:1 [8, 9]. The 2:1 K:Ca ratio assumed as optimal was found in 75 % of the trials. The forage of good quality derived from grasslands should exhibit the 1.6–2.2:1 K:(Ca + Mg) ionic ratio [7, 9]. Regarding this level none of the samples met the requirements. The range of 5–7:1 is assumed as the most optimal for the K:Na weight proportion [10, 11]. In the case of our investigations the K:Na proportion was too wide and exceeded the optimal level from 3 to 10 times. The bad forage quality resulted mainly from the high deficiency of sodium in the hay samples.

The fact of a low level of mineral components in the examined hay samples can be explained by the wrong fertilization of grasslands in the examined farms. The low level of phosphorus and calcium fertilization indicates that high amounts of liquid manure, abundant on such farms, were utilized. Under the intensive fertilization with liquid manure the higher yield increase is achieved but the effect of component dilution also appears. It results also in the changes of the nutrients availability as a consequence of the strong soil acidification visible as the decreased level of basic cations, especially Ca in plants [12]. The majority of hay samples were characterized with unfavourable weight and ionic proportions.

The supplementation of the deficient macroelements, especially P, Ca and Na in the fertilization of grasslands as well as in ruminants feeding are recommended for the examined agricultural farms [13].

Conclusions

1. Hay samples collected from the all examined farms were not characterized with optimal phosphorus, calcium and sodium content. The low level of these elements resulted from the low level of phosphorus fertilization and limited liming of the grasslands located in the area of examined farms.

2. Too high concentration of potassium indicates that the grasslands were fertilized with liquid manure. This leads to accumulation of potassium, which is calcium antagonist.

3. The Ca:Mg and K:Mg weight proportions reached the optimal values only in the case of 42 and 75 %, respectively. Other ratios between elements were characterized with unfavourable values.

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Abstrakt: Praca prezentuje ocenę składu mineralnego siana pochodzącego z gospodarstw z terenu Jury Krakowsko-Częstochowskiej specjalizujących się w produkcji mleka. Przed skarmieniem z siana pobrano próbki, po 4 z każdego gospodarstwa do analizy chemicznej. Zawartość fosforu i magnezu oznaczono kolorymetrycznie metodą wanadowo-molibdenową, potasu, sodu i wapnia metodą fotometrii płomieniowej.

Średnia ważona zawartości makroelementów w roślinach wahała się w zakresie: 1,09–2,59 g P; 14,03–24,06 g K; 3,86–6,10 g Ca; 1,71–3,33 g Mg; 0,41–1,14 g Na · kg^{-1} s.m.

W przeprowadzonych badaniach stwierdzono we wszystkich próbkach siana małą zawartość fosforu, wapnia i sodu. Niska zawartość tych pierwiastków w roślinach wskazuje na małe nawożenie fosforem i ograniczenie wapnowania użytków zielonych w badanych gospodarstwach. Jedynie zawartość potasu kształtowała się w granicach optymalnej zawartości. Przeprowadzone analizy wskazują na to, iż w badanych gospodarstwach użytki zielone nawożone są gnojowicą, w wyniku czego następuje kumulacja potasu, który jest antagonistą wapnia i magnezu.

Słowa kluczowe: siano, zawartość makroelementów, antagonizm pierwiastków