

EFFECT OF MUSHROOM SUBSTRATE ON THE FEED QUALITY FROM THE PERMANENT MEADOW

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ABSTRACT

Fodder nutritive value of permanent grassland is dependent on the concentration of individual nutrients, the degree of digestibility and energy concentration. In a grassland study on the base crude fiber content and relevant conversion formulas, digestibility of dry matter and net energy concentration of the feed can be calculated, without the need for specialized equipment. The aim of the study was to determine the effect of mushroom substrate and farmyard manure supplemented NPK, on the digestibility and energy concentration in the sward of permanent meadows in three-year field experiment. In the study, overall digestibility and net energy concentration of feed derived from permanent grassland remained at a high level. Overall digestibility of yield dry matter of grass varies significantly, depending on the collected cuts and year of study, while the net energy concentration did not show differences under the influence of experimental factors studied. Mushroom substrate used in the experiment (alone and completed mineral NPK) caused no significant effect on the digestibility and net energy concentration of the tested feed with regard to both the farmyard manure used as standard and with NPK.

Keywords: mushroom substrate, crude fiber, net energy, feed digestibility, permanent meadow.

INTRODUCTION

In view of the natural fertilization deficient one should be looking for new ways to increase organic matter in cultivated soils. One of them is the use of waste organic materials as substrate after mushrooms cultivation, whose annual capacity in Poland amounted 1 500 000 tones [Kalembasa, Wiśniewska 2004, 2008 a and b].

The spent mushroom substrate is a potentially a good material for fertilizer and a particularly valuable source of organic matter and available forms of nutrients. Also has a generally neutral reaction, the preferred C: N ratio and low heavy metal content [Kalembasa, Wiśniewska 2001, Jankowski et al. 2005]. Mushroom substrate is often characterized by a large diversity of chemical composition, which is mainly related to the composition of the starting materials, production technology and the size of mush-

rooms yield. Therefore, for fertilization it can be require a continuous analysis of the chemical composition.

The study shows that mushroom substrate can be used to fertilize at arable land and permanent grasslands in horticulture, or in orchards, and to the establishment and maintenance of green areas [Rak et al. 2001, Kalembasa, Wiśniewska 2004, 2006 and 2008, Jankowski et al. 2004, 2005, Ciepiela et al. 2007, Maszkiewicz 2010, Jankowski et al. 2012].

Meadows and pastures fertilization of determines a key factor in the value food - feed from pasture. According to many authors the type of fertilizer as well as its level has a huge impact on the botanical composition of the sward, the level of nutrients utilization implemented in these fertilizers, which is reflected in the food value of received feed [Wesołowski, Jankowska-Huflejt 1999, Niczyporuk, Jankowska-Huflejt 2000].

The productivity measure of fodder from permanent grasslands is the size of obtained yields of dry matter, protein and oat units, while about the value of food determines the concentration of each nutrient and digestibility degree [Sosnowski 2012b].

For the purposes of grassland experiments, or when comparing values of different feed from grasslands is proposed to adopt a simple, easy-to-calculate patterns, based on the current analysis of the crude fiber content [Pawlak 1988]. Based on these models, and on the content of total fiber and crude protein in feed can easily determine the value of crops.

The aim of this paper was to determine the effect of the mushroom substrate and also with manure and also with NPK supplemented on digestibility and energy concentration in the sward of permanent meadow in three-year field experiment.

MATERIALS AND METHODS

The experiment was established in the spring of 1999 with randomized block design in four replications on permanent meadow. Plots with an area of 9m² (1.5 m × 6 m) were separated by 1 meter wide paths. Paths and edge of experiment were mowed several times in order to maintain a low sward. The experiment was located on the glial ground soil.

The tested soil in humus level was slightly alkaline solution both in KCl and in H₂O, and showed a high content of nitrogen, manganese and iron, the average content of magnesium and very low content of phosphorus and potassium.

The object of the study experiment was to organic fertilization sward applied fertilization. In the study the following fertilizer objects (in the tables marked with abbreviations in parentheses) were highlighted:

- control object, without fertilization (O),
- manuring (Ob),
- fertilization with mushroom substrate (Pp),
- manuring with NPK fertilization (Ob + NPK),
- mushroom substrate fertilization with NPK (Pp + NPK).

Fertilization with manure and mushroom substrate were applied once early in the spring of 1999 in the amount of 10 t · ha⁻¹ of fresh weight. Mineral fertilization was used in each study year, nitrogen at a dose of 180 kg · ha⁻¹ (ammonium

nitrate), phosphorus – 48 kg · ha⁻¹ (TSP), potassium – 125 kg · ha⁻¹ (potassium salt). The annual amount of nitrogen and potassium were divided into three equal parts for each regrowth, phosphorus was applied once in the spring.

In each growing season three regrowth were collected. Immediately after cutting, sward from each plot were weighed to the determined yield and were collected 0.5 kg sample of green matter to determine the drying coefficient of and to chemical analysis.

On the basis of a crude fiber content estimated by the Henneberg and Stohman method modified by Lepper, stated in an earlier publication of Ciepiela et al. [2007] and proposed by Pawlak [1988] the conversion formulas dry matter digestibility and concentration of net energy were calculated:

$$K = 1.50 - 0.02 x$$

where: K – net energy concentration in 1 kg D.M.

x – crude fiber content in % D.M.

% D.M. $S = 103 - 1.2 x$ D.M.

S – dry matter digestibility in %.

The results were statistically evaluated using the analysis of variance. Calculations were performed using STATISTICA, and for means comparisons were used Tukey's test at a significance level $\alpha \leq 0.05$.

According to the meteorological station ZSD Zawady in the studied growing seasons (IV - IX) average air temperatures were 16.5 °C (average of several years 12.5 °C) and precipitation totals were 16.5 mm and compared to multi-year were higher by 66.7 mm.

RESULTS AND DISCUSSION

Statistical analysis showed significant differences of total digestibility of obtained dry matter yield of grass depending on the regrowth yield and the study year, whereas the type of fertilization did not affect significantly the value of the study characteristic (Table 1).

Total digestibility (average from years, objects, and cuttings) of dry matter sward obtained from permanent meadow was at a relatively high level of 69.9%.

Analyzing the hay yield (average from the years and cuts) from each fertilizing objects by higher digestibility characterized the forage harvested from objects fertilized with mushroom



Table 1. Influence the kind of fertilization, cut and years of research on the digestibility of feed for permanent meadow (%)

Years	Cut	Fertilized object					Mean
		O	Ob.	Pp.	Ob. + NPK	Pp + NPK	
1999	1	71.0	68.2	70.9	70.3	69.4	69.9
	2	71.9	69.5	71.1	68.7	69.9	70.2
	3	70.3	67.9	70.2	69.1	68.1	69.1
	x	70.9	68.5	70.2	69.4	69.1	69.6
2000	1	70.9	73.2	69.5	67.9	70.5	70.4
	2	69.4	69.2	71.8	65.1	68.2	68.7
	3	73.8	73.3	73.0	73.5	75.7	73.8
	x	71.3	71.8	70.4	68.9	71.5	70.8
2001	1	68.8	67.0	71.2	68.4	69.4	68.9
	2	69.1	69.5	67.3	69.1	69.3	68.8
	3	68.8	69.9	69.7	70.3	70.4	69.8
	x	68.9	68.8	69.4	69.3	69.7	69.2
Mean	1	70.2	69.4	70.5	68.9	69.8	69.8
	2	70.1	69.4	69.1	67.6	69.1	69.1
	3	70.7	70.4	70.5	71.0	71.4	70.8
	x	70.4	69.7	70.0	69.2	70.1	69.9
LSD _{0.05}	A – fertilization B – cut C – years	A = n.s. A/B = n.s. C/A = n.s.	B = 1.09 B/A = n.s. B/C = 1.88	C = 1.09 A/C = n.s. C/B = 1.88			

substrate and NPK (70.1%) and also with mushroom substrate used alone (70.0%), than from the objects of manure and NPK (69.2%) or the manure (69.7%).

The highest digestibility of tested feed (average for three years) was recorded for the third cut in all fertilizers combinations. Higher digestibility of hay were recorded on the objects fertilized with manure and mushroom substrate supplemented with mineral fertilization NPK (respectively 71.0 and 71.4%) than in the objects fertilized with the manure (70.4%) or with the substrate after mushroom cultivation (70.5%).

Average from fertilizer in all objects in the first study year, the highest digestibility of feed were obtained in the second cut (70.2%), in the second year for the third cut (73.8%) and in the third year for the third cut (69.8%).

The results obtained in the present study, were similar to those obtained by Pawlak [1988]. Jankowski, et. al. [2000] also noted a high digestibility in compound grass legume mixtures harvested at different terms.

The statistical analysis showed no significant differences for concentration of the net obtained in the energy yield of grass dry matter, depending on the cut study year, as well as the type of fertilization (Table 2).

The concentration of energy is dependent on the crude fiber content, what is decisive about the amount in the feed of digestible organic matter processed for livestock products. Nutritioners argue that the energy concentration should not be less than 0.7 of oats units per 1 kg of dry matter.

The concentration of net energy (average for years objects and cuts) in the dry matter of the sward obtained from permanent meadow was at a relatively high level (0.94 o.u./kg D.M.). The concentration of net energy (average from year and cuts) in the feed obtained from objects fertilized with the mushrooms substrate used alone and supplemented with mineral fertilization NPK was identical (0.95 o.u./kg DM) but energy concentration obtained from the object fertilized with the manure was slightly higher (0.94 u.o./kg D.M.) than in the feed from the object where the manure with NPK (0.93 u.o./kg D.M.) was applied.

Like for the digestibility, the highest energy concentration of the tested feed (average from three years) was recorded in the third cut in all fertilizing combinations except the object fertilized with manure. Greater energy concentration in the hay obtained in the cut has reported on objects fertilized with manure and with mushroom substrate supplemented with mineral fertilizers NPK (respectively 0.96 and 0.97 o.u./kg D.M.)

Table 2. The influence of the kind of fertilization, cut and years of research on the net energy concentration in the feed from permanent meadow (o.u./kg DM)

Years	Cut	Fertilized object					Mean
		O	Ob.	Pp.	Ob. + NPK	Pp. + NPK	
1999	1	0.96	0.92	0.96	0.95	0.94	0.94
	2	0.98	0.94	0.92	0.92	0.94	0.94
	3	0.95	0.91	0.92	0.93	0.91	0.92
	x	0.96	0.92	0.95	0.94	0.93	0.94
2000	1	0.96	1.30	0.94	0.91	0.95	1.01
	2	0.94	0.93	0.93	0.86	0.91	0.91
	3	1.01	1.00	1.00	1.00	1.04	1.01
	x	0.93	0.98	0.95	0.93	0.97	0.95
2001	1	0.93	0.90	0.97	0.92	0.94	0.93
	2	0.93	0.94	0.90	0.93	0.93	0.93
	3	0.93	0.94	0.94	0.95	0.95	0.94
	x	0.93	0.93	0.94	0.93	0.94	0.93
Mean	1	0.95	0.93	0.95	0.93	0.94	0.94
	2	0.95	0.94	0.93	0.91	0.93	0.93
	3	0.96	0.86	0.95	0.96	0.97	0.94
	x	0.95	0.94	0.95	0.93	0.95	0.94
LSD _{0.05}	A – fertilization B – cut C – years	A = n.s. A/B = n.s. C/A = n.s.	B = n.s. B/A = n.s. B/C = n.s.	C = n.s. A/C = n.s. C/B = n.s.			

than on the objects fertilized with manure (0.86 o.u./kg D.M.) and with the mushrooms substrate after cultivation (0.95 o.u./kg D.M.).

Average from all fertilizer objects largest net energy concentration (1.01 o.u./kg D.M.) was recorded in the first and third cut in the second study year; the smallest digestibility of feed was recorded in the second cut (0.91 o.u./kg D.M.) in the same study year.

Digestibility and energy concentration are very important indications of the biological value of forage. These ratios depend largely on crude fiber content, which largely determines the amount in feed and the digestible organic matter mass processed into animal products [Borowiecki in 2000, Sosnowski 2012 b].

Our results clearly show that the digestibility and energy level of tested feed derived from permanent meadow was very high. They are reflected in similar studies conducted by Jankowski et al. [2000] and Ziliotto et al. [2003].

CONCLUSIONS

1. Total digestibility of feed derived from permanent meadow was at a high level and showed

significant differences depending on the crop cut and the study year.

2. The concentration of net energy in the yield of dry matter of feed received was very high and statistical analysis showed no significant influence of study factors.
3. Gowing substrate mushrooms used in the experiment and supplemented with NPK did not cause a significant impact on the digestibility and net energy concentration of the tested feed for manure used separately and with NPK applied as standard.

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