

FODDER VALUE OF HAY FROM EXTENSIVELY USED *ARRHENATHERETUM ELATIORIS TYPICUM* COMMUNITY

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Abstract. Presented investigations were conducted in 2007–2009 on a permanent meadow covered by the Agri-Environmental programme for the years 2007–2013. A meadow with prevailing tall oat-grass (*Arrhenatherum elatius* L.) was situated in Gnatowice village near Krakow. The research aimed to determine the feed value of hay from extensively used *Arrhenatheretum elatioris typicum* community on the basis of yielding, total protein, crude fat, digestible nitrogen free extracts, crude fibre and the share of fibre fraction. The *Arrhenatheretum elatioris typicum* meadow provided a good quality hay (Urn was 7.7 and 7.6). Presence of 40 species was detected in its sward, whereas summary yields of dry mass fluctuated from 4.92 to 6.57 t·ha⁻¹. The analyzed hay revealed diversification in the amount of energy nutrients and crude ash. Considering the nutrition aspect, the analysed hay samples contained low quantities of total protein and crude fat but higher amounts of crude fibre and digestible nitrogen-free extracts. The content of neutral-detergent fibre (NDF) and acid-detergent fibre (ADF) was high and exceeded the quantities stated in nutritional standards.

Key words: *Arrhenatherum elatioris typicum*, extensive use, botanical composition, chemical composition, fodder value

INTRODUCTION

Arrhenatheretum elatioris community belongs to the best researched communities in Poland, regarding its floristic composition [Kryszak et al. 2008]. Its wide ecological amplitude causes that it is floristically diversified, which results both from the habitat conditions and intensity of use and fertilization [Bator 2005, Kryszak and Kryszak 2007]. In dry-ground habitats, moderately used, the community develops in a typical form. However, currently *Arrhenatheretum elatioris* meadows developed in a typical form are increasingly rarely encountered. On one hand it is the consequence of their former intensive use and on the other a drastic limiting or abandonment of use [Kryszak et al. 2006, Kryszak et al. 2008]. A chance to maintain such habitats or even may be increasing the area of these communities is including them in so called agri-environmental programme involving realization of specific activities aiming at maintaining biodiversity, mainly through extensive utilization, i.e. cutting maximum twice a year and low fertilization rate [MRiRW 2007].

The research was conducted to determine the feed value of hay from extensively used *Arrhenatheretum elatioris typicum* community on the basis of yielding and basic chemical composition (the content of crude ash, total protein, crude fat, digestible nitrogen free extracts, crude fibre and the share of fibre fractions).

MATERIALS AND METHODS

The investigations were conducted in 2007–2009 on a permanent meadow covered by the Agri-Environmental Programme for the years 2007–2013. A plant community with dominating *Arrhenatherum elatius* L. covering the area of about 0.5 ha, located in Gnatowice (50°20' N, 20°18' E) village about 30 km north-east from Krakow (220 m a.s.l.) was selected for the investigations.

Until 2005 the meadow was cut twice, then it was abandoned and since 2007 it has been included in the agri-environmental programme. In April 2007 ten soil samples were collected at random from the meadow, from which a collective sample was obtained. The following chemical assessments were made in the collected soil material: pH in 1 mol·dm⁻³ KCl was determined by potentiometer, organic matter content by gravimetric method, calcium carbonate by Scheibler's volumetric method, bioavailable phosphorus concentration by Egner-Riehm method, bioavailable potassium by Egner-Riehm's method using flame photometry and bioavailable magnesium using atomic absorption spectrometry (AAS) after the extraction in 0.0125 mol CaCl₂·dm⁻³.

The soil chemical properties were as follows: pH_{KCl} – 6.8; bioavailable: P – 131.0, K – 218.0 and Mg – 116.0 mg·kg⁻¹; organic matter content – 25.6 g and calcium carbonate – 41.5 g·kg⁻¹.

In compliance with the guidelines stated in the Agri-Environmental Programme for the years 2007–2013, in 2007 the meadow fertilization was started at the rate of 60 kg N·ha⁻¹ in the form of ammonium nitrate (34%). Two doses of nitrogen were applied: 36 kg N·ha⁻¹ (i.e. 60% of the total amount) under the first cut and 24 kg N·ha⁻¹ (40%) under the second.

The community was used twice during the vegetation period. Each year harvesting of the first cut was done at the beginning of June and the second cut was made by the end of August. The plants were cut at the height of about 10 cm, on 95% of the meadow.

Botanical composition of the meadow sward was estimated prior to the first cut harvesting using Stebler-Schröter botanical-gravimetric method (fractional analysis) and Klapp's estimation method. Moreover the plant community was estimated in use value numbers (Lwu) basing on percentage share and use value of each species [Filipek 1973].

The sward yielding was assessed by means of cutting plants from the area of 0.5 m² in randomly chosen 10 replications. Collected representative plant samples were dried in order to determine dry mass content, then cut and ground.

Chemical analysis was conducted on ten representative samples of the material: dry mass was determined by means of dryer method at the temperature of 105°C, basic chemical composition was assessed using AOAC system methods [2003], while the share of NDF, ADF and ADL fibre shares according to Van Soest et al. [1991] on ANCOM 220 apparatus.

Assessments conducted each year of the investigations comprised: botanical composition, dry mass content in the sward of two cuts and basic chemical composition but only in sward of the first cut.

Annual precipitation total in Gnatowice during the period of investigations fluctuated from 457.4 to 716.8 mm, whereas precipitation total for six months (April – September) ranged from 327.5 to 573.1 mm. Average annual temperature reached the values between 6.1–6.8°C, whereas during the vegetation period between 11.9 and 12.6°C.

The paper presents results of floristic analysis of *Arrhenatherum elatioris typicum* in the first and third year of the research and dry mass yields for the three years of the investigations. Moreover the paper contains the results of chemical composition obtained during laboratory analyses of the sward of the first cut for the research period 2007 and 2009.

RESULTS AND DISCUSSION

According to Kryszak et al. [2008], *Arrhenatheretum elatioris typicum* phytocenoses reveal a considerable floristic richness. The Authors identified between 25 and 49 species in a single photograph. As reported by Kucharski [1999], changes in floristic composition of *Arrhenatheretum elatioris* meadows are significantly affected by cutting intensity. Meadows cut more often (three times) are poorer floristically, because wild species become replaced by grass cultivars.

40 species were identified in the sward of the analysed *Arrhenatheretum elatioris* meadow (Tab. 1). Grasses constituted the dominant fraction with share reaching 82 and 79% in the subsequent years. The share of *Arrhenatherum elatius* L. made up respectively 24 and 21%. In the following years of the research the number of herb, weed and legume fractions were growing at the cost of grasses.

Table 1. Botanical composition of *Arrhenatheretum elatioris typicum* community (%)

Specification	Years	
	2007	2009
Grasses	82	79
<i>Arrhenatherum elatius</i> L.	24	21
<i>Dactylis glomerata</i> L.	15	12
<i>Poa pratensis</i> L.	9	11
<i>Poa trivialis</i> L.	8	7
<i>Festuca rubra</i> L.	7	9
<i>Bromus mollis</i> L.	5	4
<i>Agrostis capillaris</i> L.	3	5
<i>Festuca pratensis</i> Huds.	3	2
<i>Agropyron repens</i> L.	2	3
<i>Bromus inermis</i> L.	2	1
<i>Alopecurus pratensis</i> L.	1	1
<i>Anthoxanthum odoratum</i> L.	1	1
<i>Holcus lanatus</i> L.	1	2
<i>Lolium multiflorum</i> L.	1	-
Legumes	7	8
<i>Trifolium pratense</i> L.	3	2
<i>Trifolium repens</i> L.	2	4
<i>Lotus corniculatus</i> L.	1	1
<i>Trifolium dubium</i> Sibth.	1	1
Herbs and weeds	11	13
<i>Galium molugo</i> L.	1	1
<i>Plantago lanceolata</i> L.	1	1
<i>Taraxacum officinale</i> Web.	1	1
<i>Achillea millefolium</i> L.	1	1
<i>Leontodon hispidus</i> L.	1	1
<i>Leucanthemum vulgare</i> Lam.	1	1
<i>Ranunculus acer</i> L.	1	1
<i>Ranunculus repens</i> L.	1	1
<i>Veronica chamaedrys</i> L.	+	1
<i>Cardamine pratensis</i> L.	+	1
<i>Daucus carota</i> L.	+	1
<i>Geranium pratense</i> L.	+	+
<i>Glechoma hederacea</i> L.	+	+
<i>Heracleum sphondylium</i> L.	+	+

Table 1. cont.

<i>Knautia arvensis</i> (L.) Coult.	+	+
<i>Lathyrus pratensis</i> L.	+	+
<i>Rumex acetosa</i> L.	+	+
<i>Rumex crispus</i> L.	+	+
<i>Sanguisorba officinalis</i> L.	+	+
<i>Solidago canadensis</i> L.	+	+
<i>Tragopogon pratensis</i> L.	+	+
<i>Vicia cracca</i> L.	+	+
Urn	7,7	7,5

Economic value of *Arrhenatheretum elatioris typicum* community expressed in use value numbers (Lwu) was 7.7 in the first year of investigations and 7.6 in the third year.

During the period of investigations total yields of dry mass from the *Arrhenatheretum elatioris* meadow fluctuated from 4.92 to 6.57 t·ha⁻¹ (Tab. 2), whereas hay yield from the first cut ranged from 3.14 to 4.26 t·ha⁻¹. Wylupek [2006] reports that average yield of dry mass from the spring regrowth of semi-natural *Arrhenatheretum elatioris* community meadow in the Huczwa River valley in south-eastern Poland was low, amounting to 3.14 t·ha⁻¹. On the other hand, meadows of *Arrhenatheretum elatioris* community in the Wyznica river valley, analyzed by Miazga and Mosek [2001] were characterized by a slightly better yielding (4.0 t·ha⁻¹).

Table 2. Yields of dry matter (t·ha⁻¹)

Years	Cuts		Sum
	I	II	
2007	4.26	2.31	6.57
2008	3.14	1.78	4.92
2009	3.58	1.95	5.53
LSD _{0.05}	0.62	0.41	0.52

Arrhenatheretum elatioris typicum community meadow in 2007–2009 were diversified (Tab. 3). The highest variation coefficient was computed for crude ash content (24.4%). This differentiation in ash content might have been caused by a slight pollution of some samples with soil. On the other hand, the lowest variation coefficient was computed for digestible nitrogen-free extracts (5.8%). Medians of digestible nitrogen-free extracts in feed samples were respectively in the years of investigations: 512 and 510 g·kg⁻¹ d.m.

Medians of crude fibre in the analyzed hay samples, which is an important standard of feed digestibility and as a rule negatively correlated with total protein content [Nazaruk et al. 2009], were similar in the subsequent years of research and were: 274 and 273 g·kg⁻¹ d.m. On the other hand, medians of total protein quantity reached the values of 121 and 110 g·kg⁻¹ d.m.

Table 3. Chemical properties of hay from the first cut from the *Arrhenatheretum elatioris typicum* meadow (g·kg⁻¹ dry matter)

Sample number	Crude ash		Total protein		Crude fat		Crude fibre		Nitrowe-free extracts	
	Years									
	2007	2009	2007	2009	2007	2009	2007	2009	2007	2009
1	61.2	84.6	115	88	30.4	29.5	264	316	529	483
2	59.7	75.9	128	117	27.8	30.6	271	286	514	490
3	83.9	62.8	135	128	31.2	31.0	299	275	452	503
4	73.5	60.4	103	97	26.7	26.7	257	264	540	552
5	43.8	51.7	95	104	28.9	33.2	247	316	585	495
6	52.6	47.3	148	116	30.3	27.1	319	342	450	467
7	81.0	58.9	129	124	24.5	31.8	293	259	472	526
8	65.2	72.1	116	96	32.6	28.3	276	272	510	532
9	70.8	91.4	126	134	29.4	32.7	284	224	490	518
10	53.1	43.6	99	106	31.2	26.4	248	269	569	556
Mediana	63.2	61.6	121	111	29.9	30.1	274	273	512	510
Sd	12.9	15.9	17.0	15.5	2.4	2.5	23.2	34.3	46.2	29.7
V(%)	20.0	24.4	14.2	13.9	8.2	8.5	8.4	12.2	9.0	5.8

According to Brzóška [2008], between 150 and 170 g·kg⁻¹ d.m. is considered as the limit, minimum protein content in feed, which conditions relatively right digestion in the dairy cow alimentary tract and usually meets their requirements for this component, even at big milk production. None of the fodders fell within this range.

Crude fat concentrations in hay were relatively stabile during the period of investigations, as evidenced by the medians – 29.9 and 30.1 g·kg⁻¹ d.m. Most probably it was connected with plant being harvested always at the same development phase. According to Nazaruk et al. [2009], among others the quantities of crude fat in feeds depend on plant development stage during harvest. Computed variation coefficients for crude fat content in hay samples reached the value of 8.2 and 8.5%.

Medians of fibre fraction content in hay from *Arrhenatheretum elatioris typicum* community meadow fell within the rage of between 446–474 g (NDF), 338–340 g (ADF), 62–62 g (ADL) and 268–283 g·kg⁻¹ d.m. (cellulose) (Tab. 4).

The highest variation coefficient (V=18.1%) was calculated for the share of acid- detergent lignin (ADL) in the final year of the investigations. Big amounts if this component (reaching 148 g·kg⁻¹ d.m.) indicate a far advanced lignification process [Kotlarz et al. 2010]. Mikhailova et al. [2000] report equally high lignin content in the aboveground, dead plant parts originating from one-swath meadows.

According to NRC [2001], the content of NDF and ADF in dry mass of traditional feeds for dairy cows should range respectively from 28 to 32% and from 19–21%. The analyzed feeds did not meet this criterion.

Table 4. Participation of fibre fractions of hay from the first cut from the *Arrhenatheretum elatioris typicum* meadow (g·kg⁻¹ dry matter)

Sample number	Fibre fractions							
	NDF		ADF		ADL		ADF-ADL*	
	Years							
	2007	2009	2007	2009	2007	2009	2007	2009
1	419	519	327	317	46.9	53.6	280	264
2	467	487	351	350	53.7	82.5	298	267
3	510	428	407	362	70.2	70.2	337	291
4	430	457	318	319	68.4	61.0	250	258
5	432	503	335	327	60.3	58.4	275	269
6	458	417	307	317	71.0	65.1	236	252
7	527	409	422	349	51.4	73.7	370	275
8	504	525	382	425	64.5	41.8	318	383
9	418	461	346	437	59.8	56.9	286	380
10	433	496	328	315	67.1	62.3	261	253
Mediana	446	474	340	338	62.4	61.7	283	268
Sd	40.7	42.2	38.7	44.9	8.4	11.3	41.1	50.0
V (%)	8.9	9.0	11.0	12.8	13.7	18.1	14.1	17.3

*ADF-ADL – cellulose

The lowest variation coefficient (V=8.9%) was computed for neutral detergent fibre (NDF) in the first year of the investigations.

CONCLUSIONS

1. *Arrhenatheretum elatioris typicum* community meadow produced good quality hay (Lwu 7.7 and 7.6). Presence of 40 species was detected in its sward where the dominant fraction were grasses.
2. Total yields of dry mass fluctuated from 4.92 to 6.57 t·ha⁻¹.
3. The quantities of energy nutrients and crude ash in hay were diversified. Considering nutritional quality the hay samples contained small amounts of total protein and crude fat but higher quantities of crude fibre and digestible nitrogen-free extracts.
4. High concentrations of neutral detergent fibre (NDF) and acid detergent fibre (ADF), exceeding the limits stated by nutritional standards were assessed in the analysed hay.

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B. GRYGIERZEC

**WARTOŚĆ PASZOWA SIANA Z EKSTENSYWNIE UŻYTKOWANEGO ZBIOROWISKA
*ARRHENATHERETUM ELATIORIS TYPICUM***

Synopsis. Badania prowadzono w latach 2007–2009 na łące trwałej, objętej Programem Rolnośrodowiskowym na lata 2007–2013. Do badań wybrano łąkę z dominacją rajgrasu wyniosłego zlokalizowaną w Gnatowicach koło Krakowa. Celem podjętych badań było określenie wartości paszowej siana z ekstensywnie użytkowanego zbiorowiska *Arrhenatheretum elatioris typicum* na podstawie plonowania oraz podstawowego składu chemicznego (zawartości: popiołu surowego, białka ogólnego, tłuszczu surowego, związków bezazotowych wyciągowych, włókna surowego oraz udziału frakcji włókna). Łąka *Arrhenatheretum elatioris typicum* dostarczyła siana dobrej jakości (Lwu wynosiło 7,7 i 7,6). W jej runi stwierdzono obecność 40 gatunków, a sumaryczne plony suchej masy wahały się od 4,92 do 6,57 t·ha⁻¹. Natomiast plony siana pierwszego pokosu zawierały się w przedziale od 3,14 do 4,26 t·ha⁻¹. W analizowanym sianie wykazano zróżnicowane ilości energetycznych składników pokarmowych

i popiołu surowego. Pod względem żywieniowym próby siana zawierały niskie ilości białka ogólnego oraz tłuszczu surowego, a wyższe włókna surowego i związków bezazotowych wyciągowych. Zawartość frakcji włókna neutralno-detergentowego (NDF) oraz kwaśno-detergentowego (ADF) była wysoka i przekraczała ilości podane w normach żywieniowych.

Słowa kluczowe: *Arrhenatherum elatioris typicum*, użytkowanie ekstensywne, skład botaniczny, skład chemiczny, wartość paszowa