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QUALITY OF GREEN MATTER AND SILAGES FROM PERENNIAL GRASSES DURING THE GROWING SEASON

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Abstract

The goal of the work was to assess the fodder quality of selected grasses during the growing season. The assessment was made of green matter quality and subsequently of the quality of silages produced from the first cut (early June) and of green matter quality in the second and third cuts (end July, early October). Species included in the assessment were *Festulolium pabulare*, *Festulolium braunii*, *Lolium perenne* and a mixture of these species with *Festuca rubra*, resp. *Poa pratensis*. In the production of silages from the first cut, we used chemical ingredient (formic acid, propionic acid, ammonium formate) and biological additive (4 bacterium and 4 enzymes). Assessed parameters were DOM, crude fibre content, NDF, ADF and crude proteins. Safety was evaluated from the contents of mycotoxins Fumonisin, Aflatoxin and Zearalenone. Silages sampled 60 days after the beginning of conservation were assessed for pH, acidity of water extract, contents of organic acids and ethanol. *Lolium perenne* had the highest ($P<0.05$) content of N-substances. The content of zearalenone was the lowest ($P<0.05$) in the *Festulolium pabulare*, in which the measured values were below the detection limits. Other species exceeded the limit of 100 ppb. The zearalenone content was increasing during the growing season ($P<0.05$). Although the *Festulolium pabulare* and *Lolium perenne* showed the high contents ($P<0.05$) of N-substances in the ensilaged material, *Lolium perenne* exhibited also the low contents of crude fibre, NDF and ADF as compared with the *Festulolium pabulare*. The treatment with conservation additives had a beneficial influence ($P<0.05$) on the suppression of zearalenone content and on the increase of lactic acid content.

Keywords: *Festulolium*, *Lolium perenne*, nutritive value, fermentation process, mycotoxins

Introduction

Grasslands can be used by applying the method of rotation. Crop from the first cut is harvested for conservation and the sward can be subsequently used until the end of the growing season for grazing. Winter feed ration is based on the conserved fodder from the first cut and serves also as additional feed in the autumn. The requirement of conserved feeds in extending the grazing season is difficult to estimate because it depends on the general character of weather (*Achilles et al.* 2002). The above mentioned method of grassland use is particularly suitable for Festulolium (*Opitz von Boberfeld* and *Banzhaf*, 2006).

Suitable for conservation is the first cut of permanent grasslands (*Opitz von Boberfeld*, 1994). As compared with haymaking, ensiling represents a much lower weather risk, which reflects favourably in working costs and low conservation losses (*Achilles et al.* 2002). Prerequisite for high-quality silage are not only bacteria of lactic fermentation but also a clean and healthy phytomass. Individual graminaceous species show great differences in their ensiling capacity (*Holúbek et al.* 2007).

The goal of the paper is assess quality and safety of selected grasses (*Lolium perenne*, *Festulolium pabulare*, *Festulolium braunii*) and their mixtures with *Festuca rubra* respectively *Poa pratensis* during the growing season. Quality and safety of silages produced from the above-mentioned species using chemical and/or biological additives were evaluated.

Material and methods

Experimental locality

The small-plot experiment was conducted in the Research Station of Fodder Crops in Vatín, Czech Republic (49°31'N, 15°58'E) and established in 2007 at the altitude of 560 m a.s.l. In 1970-2000, mean annual precipitation was 617 mm and mean annual temperature was 6.9 °C. In year of observation (2008), annual precipitation was 705 mm and mean annual temperature was 7.9 °C. Soil type used in our experiments was Cambisol as a sandy-loam on the diluvium of biotic orthogneiss. Soil nutrient content was in year of observation 89.1 mg kg^{-1} P, 231.6 mg kg^{-1} K, 855 mg kg^{-1} Ca and pH was 4.76.

Experimental design

A split plot design was used with plots of 1.5 × 10 m. The main plots were species and the subplots were harvest dates. The experiment was carried out in triplicates.

The first evaluated factor was species with levels *Lolium perenne* (cv. Kenatur), *Festulium pabulare* (cv. Felina), *Festulolium braunii* (cv. Perseus), mixtures of these species with *Festuca rubra* (cv. Gondolin) and/or P*oa pratensis* (cv. Slezanka). The share of *Festuca rubra* and/or *Poa pratensis* in the mixture was 15 %. The second evaluated factor was harvest date with levels in June, July and October. Evaluated factors in the production of silages from the first cut were species (see above) and preservative with levels without preservative, chemical ingredient (formic acid, propionic acid, ammonium formate) and biological additive (*Enterococcus faecium*, *Lactobacillus plantarum*, *Pediococcus acidilactic*i, *Lactobacillus salivarius*, cellulase, hemicellulase, and amylase). The amount of chemical ingredient was 4 l t^{-1} and the amount of biological additive was 10 g t^{-1}.

Pure stands of each species were sown with 30 kg ha^{-1} seeds and each mixture was sown at 37.5 kg ha^{-1}. The experimental plots were fertilized with 50 kg ha^{-1} N. Dates of cuts were 9 June, 29 July and 8 October. The plots were harvested by self-propelled mowing machine with an engagement of 1.25 m. Harvested area was 12.5 m^2. Biomass from the first cut (June) was after wilting (48 hrs) ensilaged in containers whose diameter and height were 0.15 m and 0.64 m, respectively. Dry matter content of ensilaged biomass was 42.3 % in *Lolium perenne,* 55.2 % in *Festulolium pabulare,* 44.5 % in *Festulolium braunii,* 48.6 % in the mixture with *Festuca rubra* and 48.9 % in the mixture with *Poa pratensis.*

Detected parameters

The green forage samples and silages dried at 60 °C and homogenized to a particle size of < 1 mm were analyzed for digestibility of organic matter (DOM), crude protein content (CP), crude fibre content (CF), neutral detergent fibre (NDF) and acid detergent fibre (ADF). Silages sampled 60 days after the beginning of conservation were assessed for pH, acidity of water extract (AWE), contents of lactic acid (LA), acetic acid (AA) and ethanol. The content of nutrients was established according to the norm of the Czech Standard Institute (Anonymous, 1997). ELISA method was applied for estimated of content of mycotoxins fumonisin (FUM), aflatoxin (AFL) and zearalenone (ZEA) in green matter and silages.

Statistical analyses

Data were processed using the STATISTICA.CZ Version 8.0 (Czech Republic). Results are expressed as means. The obtained results were further analyzed using the multi-factor analysis of variance with a subsequent verification based on the Tukey Test.

Results and discussion

The studied species differed in their contents of crude proteins (CP) (*Table 1*).

***Table 1*. Influence of species and harvest date on the digestibility of organic matter (DOM), content of crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), crude protein (CP) and zearalenone (ZEA)**

Factor	DOM %	CF %	NDF %	ADF %	CP %	ZEA ppb
Species						
Lolium perenne	78.59	26.35	51.83	31.75	9.68^{a}	103.57^{ab}
Festulolium pabulare	77.13	29.08	57.46	33.33	8.06^{b}	0.00^{a}
Festulolium braunii	78.66	28.46	55.06	33.67	7.99^{b}	242.67^{ab}
Mixture with *Festuca rubra*	79.01	28.73	55.49	32.93	8.06^{b}	305.87^{b}
Mixture with *Poa pratensis*	78.36	28.75	55.01	33.38	7.71^{b}	300.30^{b}
s.e.d.	2.885	1.149	1.524	1.412	0.443	77.15
Cut						
June	76.71	33.05^{a}	61.54^{a}	38.40^{a}	6.62^{a}	0.00^{a}
July	79.48	27.31^{b}	53.25^{b}	31.98^{b}	8.39^{b}	244.42^{b}
October	78.87	24.46^{b}	50.12^{b}	28.65^{b}	9.89^{c}	327.02^{b}
s.e.d.	2.235	0.890	1.181	1.094	0.343	59.76

Mean values in the same column with different superscripts ($^{a, b,c}$) are significant at a level of P<0.05.

The highest CP content was observed in *Lolium perenne* (P<0.05). The species differed also in respect of hygienic character as expressed by the content of mycotoxins. Of screened mycotoxins, zearalenone was detected, its lowest amount being found in *Festulolium pabulare* (P<0.05). Based on the content of zearalenone, the hybrid of *Festuca arundinacea* appears as the most resistant to fungal diseases. The fact was corroborated by *Skládanka et al.* (2009) or *Opitz von Boberfeld* and *Banzhaf* (2006). In the first cut harvested at a stage of ear-formation until the beginning of flowering, we observed a low CP content (P<0.05) on the one hand, and high contents of CF, NDF and ADF (P<0.05) on the other hand. Herbage from the first cut was not contaminated by mycotoxins (P<0.05). In the second and third cuts, the CP content was higher and the CF, NDF and ADF contents were lower (P<0.05). However, the stand exhibited a higher contamination by mycotoxins (P<0.05). The higher contents of organic nutrients in the second and third cuts were affected by the phenological stage of harvest. Winter species were harvested at a stage of leafy shoots.

Silage made from the biomass of *Festulolium pabulare* had a higher LA content and higher AWE (P<0.05) notwithstanding the fact that the species was ensilaged at 55 % DM (*Table 2*).

***Table 2*. Influence of species and preservative on the pH, acidity of water extract (AWE), lactic acid (LA), acetic acid (AA) and ethanol**

Factor	pH	AWE mg 100g^{-1}	LA %	AA %	Ethanol %
Species					
Lolium perenne	4.35	1148^{a}	2.76^{a}	0.579^{a}	1.21^{ab}
Festulolium pabulare	4.26	2061^{b}	3.77^{b}	0.632^{ab}	1.29^{ab}
Festulolium braunii	4.24	1273^{a}	2.48^{a}	0.573^{a}	0.82^{a}
Mixture with *Festuca rubra*	4.25	2203^{b}	3.91^{b}	0.656^{ab}	1.74^{b}
Mixture with *Poa pratensis*	4.30	2299^{b}	3.85^{b}	0.806^{b}	1.43^{ab}
s.e.d.	0.037	100.36	0.165	0.048	0.155
Preservative					
Control	4.35^{a}	1673^{a}	2.91^{a}	0.469^{a}	1.27
Kemisile	4.14^{b}	1995^{b}	3.51^{b}	0.812^{b}	1.37
Sil-all	4.34^{a}	1722^{a}	3.65^{b}	0.667^{c}	1.25
s.e.d.	0.029	77.74	0.127	0.037	0.120

Mean values in the same column with different superscripts ($^{a, b,c}$) are significant at a level of P<0.05.

Silages from the mixtures of evaluated species gave similar results. The addition of preservatives affected the increase of LA and AA contents (P<0.05). *Skládanka* and *Doležal* (2008), too, observed an increased LA content with using the same chemical preservative in lupine silages at a dose of 3 l t^{-1}. The dose of 4 l t^{-1} used in our experiment appears satisfactory for success of the conservation process and for preservation of the fermentation activity of grass silages. In contrast to this, *Britt et al.* (1975) or *Henderson* (1991) recorded a decreased activity of the bacteria of lactic fermentation when using organic acids. *Skládanka* and *Doležal* (2008) found a lower LA content in the lupine silage only at a dose of 6 l t^{-1}. The addition of chemical preservative showed a greater effect on the decrease of pH of the produced silage (P<0.05). The ethanol content was affected by the ensilaged species. The silage of *Festulolium braunii* showed a low ethanol content (P<0.05). The ensilaged biomass of *Festulolium braunii* had a lower content of dry matter as compared with *Festulolium pabulare* or with the mixtures of evaluated species. Apparent may be connection between the low dry matter content of the conserved biomass and the lower ethanol content. Nevertheless, the results indicate that alcohol fermentation occurred in all silages. *Driehuis* and *van Wikselaar* (1996) concluded that alcohol fermentation occurs in silages with the lower DM content as well as in silages with the high DM content. The achieved results do not suggest any limitation of alcohol fermentation due to the used preservatives although *Juráček* (2002) reports that a decrease in the amount of alcohol in silages occurs if microbial or chemical ensiling additives are used.

The species affected the quality of the produced silages. Silages made of *Lolium perenne* and *Festulolium pabulare* had a higher CP content (P<0.05) (*Table 3*).

Table 3. **Influence of species and preservative on the digestibility of organic matter (DOM), content of crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), crude protein (CP) and zearalenone (ZEA)**

Factor	DOM %	CF %	NDF %	ADF %	CP %	ZEA ppb
Species						
Lolium perenne	80.63^{a}	32.62^{a}	58.71^{a}	36.60^{a}	7.52^{ab}	55.67
Festulolium pabulare	73.93^{b}	35.98^{b}	64.59^{b}	41.49^{b}	7.79^{b}	48.03
Festulolium braunii	79.06^{a}	35.51^{b}	61.80^{c}	39.05^{c}	6.66^{a}	49.50
Mixture with *Festuca rubra*	81.41^{a}	34.75^{bc}	60.85^{ac}	38.36^{c}	7.00^{ab}	67.93
Mixture with *Poa pratensis*	78.72^{ab}	33.95^{ac}	60.89^{ac}	38.76^{c}	7.12^{ab}	48.60
s.e.d.	0.992	0.431	0.515	0.305	0.181	10.73
Preservative						
Control	78.30	34.79	61.50	38.94	7.10	66.86^{a}
Kemisile	78.81	34.60	61.22	38.82	7.29	34.38^{b}
Sil-all	79.14	33.78	61.38	38.80	7.27	60.60^{ab}
s.e.d.	0.769	0.334	0.399	0.236	0.140	8.31

Mean values in the same column with different superscripts ($^{a, b,c}$) are significant at a level of P<0.05.

Festulolium pabulare had high contents of CF, NDF and ADF (P<0.05). In contrast, the quality of silages made of *Lolium perenne* was accentuated by the low contents of fibre, NDF and ADF, and a higher DOM content (P<0.05). The quality of *Lolium perenne* silages was comparable with the quality of silages made from the mixtures of the evaluated grass species. Ensilaging additives had no influence on the content of organic nutrients. Although the silages treated with preservatives showed a higher CP content, the difference was not significant. According to *Skládanka* and *Doležal* (2008), however, chemical conservation decreases the level of rumen degradability of proteins. Preservatives affected the incidence of mycotoxins (P<0.05). While no mycotoxins were found in the fresh fodder in June, silages made of the same biomass exhibited the occurrence of zearalenone. The additives, chemical preservatives in particular, reflected in a lower zearalenone content (P<0.05). Other evaluated mycotoxins were not detected in the samples.

Conclusion

The quality of *Lolium perenne*, *Festulolium pabulare*, *Festulolium braunii* herbages and their mixtures with *Festuca rubra*, resp. *Poa pratensis* was comparable. A difference was found namely in the higher CP content of *Lolium perenne*. *Festulolium pabulare* appeared to be more resistant to fungal diseases. The content of mycotoxin zearalenone during the growing season was below the detection limit. Herbage of other species was contaminated with zearalenone especially in the second (July) and third cut (October). The quality of the conservation process as expressed by the LA content was higher in *Festulolium pabulare* in spite of the fact that its DM content was higher at ensilaging. Negative was the entailed higher intensity of alcohol fermentation. Silages made of *Festulolium pabulare* had a higher content of CP. On the other hand, silages made of *Lolium perenne* had a higher DOM and lower CF, NDF and ADF contents. Preservatives had no influence on the content of organic nutrients in silages. Although the green fodder was not contaminated by mycotoxins in the first cut, zearalenone was detected in the silages. Ensilaging additives contributed to reduce its content.

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