THE QUALITY OF INDICES OF GREEN MASS AND HAY FROM *ARRHENATHERUM ELATIUS* AND *FESTUCA ARUNDINACEA*, IN MOLDOVA

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Abstract

We studied the quality indices of the of green mass and hay from tall oatgrass *Arrhenatherum elatius* and tall fescue *Festuca arundinacea* which grow in the experimental sector of the "Alexandru Ciubotaru" National Botanical Garden (Institute) MSU. It was determined that the biochemical composition and nutritive value of the dry matter of the harvested plants were: 9.6-11.2% CP, 8.2-8.7% ash, 35.4-37.5% CF, 37.9-39.9% ADF, 65.3-68.4% NDF, 3.3-3.7 % ADL, 12.0-12.4% TSS, 34.6-36.2% Cel, 27.4-28.5% HC, 590-629 g/kg DMD, 538-572g/kg OMD, 11.48-11.76 MJ/kg DE, 9.43-9.66 MJ/kg ME and 5.45-5.67 MJ/kg NEl. The quality indices of the prepared hays were: 10.0-11.4% CP, 9.4-10.0% ash, 36.7-39.9% CF, 39.4-41.4% ADF, 64.6-68.3% NDF, 3.7-3.8 % ADL, 3.7-3.8% TSS, 35.7-38.0% Cel, 25.2-26.5% HC, 515-567 g/kg DMD, 471-527g/kg OMD, 11.21-11.55 MJ/kg DE, 9.20-9.48 MJ/kg ME and 5.3-5.5.50 MJ/kg NEl. The biochemical methane potential of the studied substrates varied from 343 to 354 l/kg ODM. The *Arrhenatherum elatius* and *Festuca arundinacea* species can be used to restore permanent grasslands or to create temporary grasslands, and the harvested green mass and prepared hays can be used as forages for farm animals or as substrates for biomethane production.

Key words: *Arrhenatherum elatius, biochemical composition, biomethane potential, Festuca arundinacea, nutritive value*

The ecosystems with herbaceous perennials play a part in water conservation, protecting the soil from erosion and enriching it with humus. Traditionally, perennial plants of the family *Poaceae* Barnhart are known to provide food and shelter for various species of animals, birds and insects, and are of high socio-economic value, being used to produce building materials and handicrafts, and, in recent years, they have been more commonly used as a source of different types of biofuels, raw material for the circular economy, and as cover crops and ornamental plants in open spaces in vineyards, orchards and recreational land.

On a global and regional level, the species of grasses in the genera *Arrhenatherum* P. Beauv. and *Festuca* L. are quite common in the floristic composition of permanent and temporary grasslands. The native flora of the Republic of Moldova includes only 1 species of genus *Arrhenatherum* and 8 species of genus *Festuca* (Negru A., 2007). In Romania, the genus *Festuca* is represented by 32 species and the genus *Arrhenatherum* – by 1 species (Marușca T., 1999).

The goal of this study was to evaluate the quality indices of the green mass and prepared hay from tall oatgrass (*Arrhenatherum elatius*) and tall fescue (*Festuca arundinacea*) grown under the climatic conditions of the Republic of Moldova, as feed for livestock and as substrates for biogas production.

MATERIALS AND METHODS

The local ecotype of tall oatgrass, *Arrhenatherum elatius*, and the romanian cultivar 'Măgurele 5' of tall fescue, *Festuca arundinacea*, grown in monoculture in the experimental sector of the National Botanical Garden (Institute) of Moldova, Chişinău, served as research subjects.

The experimental design was a randomized complete block design with four replications, and the experimental plots measured 10 m^2. The samples were collected in the third growing season and the first cut was done in the pre-flowering stage.

The harvested plants were chopped into 1.5-2.0 cm small pieces, with a laboratory forage chopper; the dry matter content was detected by drying the samples to a constant weight, at 105°C. The prepared hay was dried directly in the field. For chemical analyses, the plant samples were dried in a forced-air oven at 60 °C, then milled in a beater mill equipped with a sieve with mesh diameter of 1 mm. Some of the main biochemical parameters were assessed: crude protein (CP), ash, acid detergent fiber (ADF), neutral detergent fiber (NDF) and acid detergent lignin (ADL), total soluble sugars (TSS), digestible dry matter (DDM) and digestible organic matter (DOM) were determined by the near infrared spectroscopy (NIRS) technique using the

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PERTEN DA 7200 NIR analyzer, at the Research and Development Institute for Grasslands, Braşov, Romania. The concentration of hemicellulose (HC), cellulose (Cel), digestible energy (DE), metabolizable energy (ME), net energy for lactation (NEl) and relative feed value (RFV) were calculated according to standard procedures. The mass samples were collected in the early flowering stage. The carbon content of the substrates was determined using an empirical equation according to Badger C.M. *et al*, (1979). The biochemical methane potential was calculated according to Dandikas V. *et al*, (2015).

RESULTS AND DISCUSSIONS

As a result of our research, we found out that at the time when the green mass was harvested, the *Arrhenatherum elatius* plants contained 268.5 g/kg dry matter, but the *Festuca arundinacea* plants – 246.9 g/kg dry matter. The *Festuca arundinacea* green mass was characterized by a higher content of dry leaves (64%) as compared with *Arrhenatherum elatius* (58%).

Analyzing the results of the determination of the quality indices of the of harvested whole plants, Table 1, we would like to mention that the nutrient content varied within the following limits: 9.6-11.2% CP, 8.2-8.7% ash, 35.4-37.5% CF, 37.9-39.9% ADF, 65.3-68.4% NDF, 3.3-3.7 % ADL, 12.0-12.4% TSS, 34.6-36.2% Cel, 27.4-28.5% HC.

A higher concentration of crude protein, total soluble sugars, ash and a lower content of structural carbohydrates was found in the fodder from *Festuca arundinacea* plants. The concentration of nutrients influences the forage value of harvested green mass. Thus, the green fodder from *Festuca arundinacea* plants contained 629 g/kg DMD, 572g/kg OMD, 11.76 MJ/kg DE, 9.66 MJ/kg ME and 5.67 MJ/kg NEl, but – from *Arrhenatherum elatius* plants – 590g/kg DMD, 538g/kg OMD, 11.48 MJ/kg DE, 9.66 MJ/kg ME and 5.67 MJ/kg NEl. Some authors mentioned various findings about the nutrient quality of the green mass of the studied grasses.

According to Tomić Z. *et al*, (2005), the grass quality of *Arrhenatherum elatius* pasture associations was 6.28 % CP, 30.07 % CF, 8.11 % ash, but in *Festuca* pasture associations – 6.57-9.53 % CP, 27.63-29.55 % CF and 6.00-8.00 % ash. Skládanka J. *et al*, (2008) reported that the forage dry matter from *Arrhenatherum elatius* plants contained 30.2 % CF, 60.5 % NDF, 35.9% ADF, 5.46 MJ/kg NEl; *Dactylis glomerata* plants – 28.9 % CF, 57.1 % NDF, 35.1% ADF, 5.54 MJ/kg NEl; *Festulolium* plants contained 26.9 % CF, 58.9 % NDF, 32.3% ADF, 5.84 MJ/kg NEl. Bulokhov A.D., (2014) revealed that the biochemical composition of the dry matter in the green mass of *Festuca arundinacea* was 12.0 % CP, 2.7% EE, 32.6% CF, 45.2% NFE, 9.8% ash and the nutritive value 0.37 fodder units/kg green mass and 78g DP/ fodder units. Ţîţei V. *et al*, (2019) mentioned the quality of dry matter contained in the green fodder from the studied tall fescue cultivars: 114-136 g/kg CP, 74-89 g/kg CA, 582-593 g/kg NDF, 392-396 g/kg ADF, 34-41 g/kg ADL, 322- 329 g/kg Cel, 226-229 g/kg HC, 60.3- 63.8% DDM and 57.2-62.2% OMD, 9.12-9.62 MJ/kg ME and 5.69-5.86 MJ/kg NEl. Reiné R. *et al*, (2020) reported that *Arrhenatherum elatius* plants had 421 g/kg DM with 7.6% CP, 4.5% ash, 1.6% EE, 66.5 % NDF, 35.2% ADF, 3.0% ADL, 61.5% DDM, 0.13% P, 0.50 % Ca, but *Festuca arundinacea* plants contained 455 g/kg DM with 7.2% CP, 4.4% ash, 2.0% EE, 73.3% NDF,41.1% ADF, 4.0% ADL, 56.8% DDM, 0.12% P, 0.35% Ca.

Hay is a key element in the diet of ruminant animals, mostly in the autumn-spring season but also throughout the year, providing a considerable amount of nutrients, vitamins and minerals, especially for young breeding animals, pregnant females and reproductive males, supports the motor functions of the rumen, i.e. the muscular activity of the digestive system, and rumination, an indispensable activity for a proper utilization of food.

The results concerning the biochemical composition of the hay prepared from the researched grasses are presented in Table 2. The prepared hays contained 10.0-11.4% CP, 9.4-10.0% ash, 36.7-39.9% CF, 39.4-41.4% ADF, 64.6-68.3% NDF, 3.7-3.8 % ADL, 3.7-3.8% TSS, 35.7-38.0% Cel, 25.2-26.5% HC with 515-567 g/kg DMD, 471-527g/kg OMD, 11.21-11.55 MJ/kg DE, 9.20-9.48 MJ/kg ME and 5.3-5.5.50 MJ/kg NEl. *Festuca arundinacea* hay contains higher amounts of crude protein and total soluble sugars than *Arrhenatherum elatius* hay. According to Medvedev P.F.& Smetannikova A.I., (1981), *Arrhenatherum elatius* hay contained 7.6-12.7% CP, 1.6-3.4% EE, 23.2-32.0% CF, 36.0-50.0 % NFE, 7.0-10.0 % ash. Angima S.D.& Kallenbach R.L., (2008) mentioned that the quality of hay from *Festuca arundinacea* 'Kentucky 31' was 6.37-7.85% CP and RFV= 96-98. Akdeniz H. *et al*. (2019) described the quality of the *Festuca arundinacea* hay as being characterized by the following indices: 9.86% CP, 9.54% ash, 1.15% EE, 44.85% CF, 64.05% NDF, 47.64% ADF and RFV=75.22.

A recent study has shown that anaerobic digestion is likely to be one of the most promising technologies for biomass energy recovery. Perennial grass biomass have been largely used as organics substrates in the production of biogas via an anaerobic digestion. The results regarding the quality indices of studied grass substrates and the potential for obtaining biomethane are shown in Table 3.

Table 1.

The biochemical composition and the feed value of the green mass of the studied grasses

Indices	*Arrhenatherum elatius*	*Festuca arundinacea*
Crude protein, g/kg DM	96.00	112.00
Crude fibre, g/kg DM	375.00	354.00
Ash, g/kg DM	82.00	87.00
Acid detergent fibre, g/kg DM	399.00	379.00
Neutral detergent fibre, g/kg DM	684.00	653.00
Acid detergent lignin, g/kg DM	37.00	33.00
Total soluble sugars, g/kg DM	120.00	124.00
Cellulose, g/kg DM	362.00	346.00
Digestible dry matter, g/kg DM	590.00	629.00
Digestible organic matter, g/kg DM	538.00	572.00
Relative feed value	77	85
Metabolizable energy, MJ/kg DM	11.48	11.76
Net energy for lactation, MJ/kg DM	9.43	9.66
Digestible energy, MJ/kg DM	5.45	5.67

Table 2.

The biochemical composition and the nutritive value of the hay from the studied grasses

Indices	*Arrhenatherum elatius*	*Festuca arundinacea*
Crude protein, g/kg DM	100.00	114.00
Crude fibre, g/kg DM	399.00	367.00
Ash, g/kg DM	94.00	100.00
Acid detergent fibre, g/kg DM	418.00	394.00
Neutral detergent fibre, g/kg DM	683.00	646.00
Acid detergent lignin, g/kg DM	38.00	37.00
Total soluble sugars, g/kg DM	78.00	83.00
Cellulose, g/kg DM	380.00	357.00
Digestible dry matter, g/kg DM	515.00	567.00
Digestible organic matter, g/kg DM	471.00	527.00
Relative feed value	77	84
Metabolizable energy, MJ/kg DM	11.21	11.55
Net energy for lactation, MJ/kg DM	9.20	9.48
Digestible energy, MJ/kg DM	5.23	5.50

Table 3.

The biochemical composition and biomethane production potential of the substrates from the studied grasses

Indices	*Arrhenatherum elatius*		*Festuca arundinacea*	
	green mass	hay	green mass	hay
Crude protein, g/kg DM	96.00	100.00	112.00	114.00
Nitrogen, g/kg DM	15.36	16.00	17.92	18.25
Carbon, g/kg DM	510.00	503.33	507.22	500.00
Ratio carbon/nitrogen	33.33	31.46	28.30	27.40
Acid detergent lignin, g/kg DM	37.00	38.00	33.00	37.00
Hemicellulose , g/kg DM	285.00	265.00	274.00	252.00
Biomethane potential, L/kg VS	344.00	343.00	354.00	346.00

We found that in the investigated substrates, according to the C/N ratio, which constituted 27-33, the amount of acid detergent lignin (33-37 g/kg) and hemicellulose (252-285 g/kg) met the established standards; the biochemical methane potential of studied substrates varied from 343 to 354 l/kg ODM. High biochemical methane potential was also characteristic of *Festuca arundinacea* substrates. There are different results reported in research studies conducted by other authors. Ebeling D. *et al.* (2013) found that, depending on the harvest dates and the amounts of fertilizer applied, the specific methane yield of *Arrhenatherum elatius* biomass substrates ranged between 311 and 347 l/kg VS. Goliński T. & Goliński P., (2013) reported that the harvested biomass from the semi-natural grasslands that were mainly represented by *Arrhenatherion* alliance contained 308 g/kg dry matter, 10.35 % CP, 6.36 % ash, 50.98% NDF, 31.61 % ADF and methane productivity was 338 l/kg VS. Boob et al. (2019)

remarked that the methane yield of the biomass from *Arrhenatherion* grasslands was 300 l/kg VS. Ţîţei V. *et al*, (2019) revealed that biomethane production potential of green mass substrates from *Festuca arundinacea* cultivars varied inessentially from 349 to 354 l/kg VS. Von Cossel M. *et al*, (2019) mentioned that the first-cut biomass substrate from *Arrhenatherion* grasslands were characterized by 240-297 g/kg DM, 7.0-8.1 % ash, 4.7-5.7% lignin, 29.3-31.9% Cel, 20.7-25.2 % HC, 1.4-1.7 % N and the methane yield ranged from 289 to 297 l/kg VS. Amaleviciute-Volunge K. *et al*, (2021) reported that tall fescue substrates contained 15.02 % CP, 7.52 % ash, 4.7-5.7% ADL, 27.3% Cel, 20.9 % HC and the methane yield was 191 l/kg VS. Meserszmit M. *et al*, (2021) mentioned that the herbage from the *Arrhenatherum elatius* and *Dactylis glomerata* plant community contained 8.00 % CP, 3.17% EE, 57.30 % NDF, 16.56 % HC, 29.47% Cel, 11.24 % lignin, 7.73 % ash, and methane yield was 249 l/kg VS. Zhang Y. *et al*, (2021) revealed that the methane potential of *Festuca arundinacea* herbage varied from 259 to 446 l/kg VS.

CONCLUSIONS

The local ecotype of *Arrhenatherum elatius* and the cultivar 'Măgurele 5' of *Festuca arundinacea* are suitable for grassland restoration, the creation of temporary grasslands and the harvested mass may be used as fodder for livestock, and also as substrate for biomethane production as a source of renewable energy.

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