Scientific Papers. Series A. Agronomy, Vol. LXIV, No. 1, 2021
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

THE QUALITY OF MEADOW FESCUE, *Festuca pratensis*, UNDER THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

Victor ŢÎŢEI[1], Andreea ANDREOIU[2], Vasile BLAJ[2], Adrian NAZARE[3], Cristina TENTIUC[1], Teodor MARUŞCA[2], Serghei COZARI[1], Mihai STAVARACHE[3], Natalia MOCANU[1], Ana GUŢU[1], Sergiu COŞMAN[1], Natalia CÎRLIG[1]

[1]"Alexandru Ciubotaru" National Botanical Garden (Institute), 18 Padurii Street, MD 2002, Chisinau, Republic of Moldova
[2]Research-Development Institute for Grassland, 5 Cucului Street, 500128, Brasov, Romania
[3]"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine, 3 Mihail Sadoveanu Alley, 700490, Iasi, Romania

Corresponding author email: vic.titei@gmail.com

Abstract

The main objective of this research was to evaluate the quality of green mass, prepared hay, silage and haylage from meadow fescue, Festuca pratensis 'Tâmpa', cultivated in the experimental plot of the "Alexandru Ciubotaru" National Botanical Garden (Institute), Chisinau, Republic of Moldova. The results revealed that the harvested green mass contained 25.0-29.8 % dry matter. The dry matter of the whole plant contained 112-120 g/kg CP, 361-394 g/kg CF, 78-79 g/kg ash, 374-381 g/kg ADF, 622-630 g/kg NDF, 34-38 g/kg ADL, 340-343 g/kg Cel, 241-256 g/kg HC, with nutritive and energy value 59.0-61.5% DMD, 54.2-58.1% DOM, RFV=88-89, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl. The biochemical composition, nutritive and energy value of prepared hay: 113-125 g/kg CP, 378-386 g/kg CF, 88-91 g/kg ash, 407-418 g/kg ADF, 651-673 g/kg NDF, 41-43 g/kg ADL, 366-375 g/kg Cel and 244-255 g/kg HC, 9.0-61.5% DMD, 54.2-58.1% DOM, RFV=88-89, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl. The fermented fodder, silage and haylage, are characterized by pH = 4.06-4.23, 8.0-8.1 g/kg acetic acid, 29.5-31.2 g/kg lactic acid, 106-119 g/kg CP, 380-399 g/kg CF, 89-96 g/kg ash, 402-414 g/kg ADF, 677-679 g/kg NDF, 28-31 g/kg ADL, 68-76 g/kg TSS, 374-383 g/kg Cel, 402-414 g/kg HC, with nutritive and energy value 56.9-62.2% DMD, 49.2-53.5% DOM, RFV=78-79, 11.27-11.45 MJ/kg DE, 9.63-9.71 MJ/kg ME, 5.65-5.73 MJ/kg NEl. The meadow fescue substrates used for anaerobic digestion have optimal C/N ratio, amount of lignin and hemicellulose. The biochemical methane potential of green mass substrates achieved 346-352 l/kg ODM, silage substrate – 362 l/kg ODM and haylage substrate – 355 l/kg ODM. We consider that the biomass of meadow fescue Festuca pratensis 'Tâmpa' may be used as multi-purpose feed for livestock, and also as feedstock for biogas reactors and renewable energy production.

Key words*: biochemical composition, biomethane potential, Festuca pratensis, green mass, hay, haylage, nutritive value, silage.*

INTRODUCTION

The human population on Earth is steadily growing, which leads to an increase in food and energy demands and aggravates the environmental challenges. Grasslands have a wide range of ecological functions and are home to highly diverse, specialized ecosystems. *Poaceae* is clearly one of the largest and most important families, accounting for about 24% of the Earth's vegetation, containing 777 plant genera and 11461 accepted species. *The Plant List* has mentioned 1741 species of the genus *Festuca*. Among them, 646 are accepted species names. In the spontaneous flora of the Republic of Moldova, there are 8 species.

Meadow fescue, *Festuca pratensis* Huds. (syn. *Lolium pratense* (Huds.) Darbysh.; *Tragus pratensis* (Hudson) Panzer ex B.D.Jackson; *Bromus pratensis* (Huds.) Spreng; *Bucetum pratense* (Huds.) Parn.; *Festuca elatior* subsp. *pratensis* (Huds.) Hack. *Schedonorus pratensis* (Huds.) P. Beauv.) is a long-lived, robust, glabrous, cespitose, perennial grass, native to Europe, C_3 photosynthetic pathway. Stems erect or slightly curved, 40 – 115 cm tall with 3-5 thickened nodes. Leaves narrowly linear, scaberulous along margin, 3-6 mm broad 22-30 cm long with at least 16 distinct veins on the upper part. The leaf blade is dark green, sheaths of inferior leaves – purple red. Ligule short, sometimes missing. Auricles well developed. Panicle-like inflorescence, up to 8-20 cm long,

erect, sometimes 1-sided, contracted, drooping at the tip, develops by 2 branches on the lower nodes, the biggest one is half the length of the panicle and has 4-5 spikelets, and the smallest one has 1-3 spikelets. The spikelets are lanceolate or linearly oblong, sometimes laterally compressed, short pedicellate, 9-13 mm long and 2-2.5 mm wide, with 7-8 pale greenish flowers with purple tints, the glumes are 2.5-5.0 mm long, with notched margins, the palea is narrowly lanceolate, sharp, 6-8 mm long. Blossoms in May-June, and bears fruit in July-August. Cross-pollinated by wind. The seeds are cayopses, 4.8-6.3 mm long and 0.9-1.7 mm wide. The weight of 1000 seeds is 1.3-2.2 g. The roots grow 80 cm deep into the soil. The root system is more developed in the upper layer of the soil, the growth rate – medium. This grass is mesophyte, tolerant of waterlogged soils, very well resistant to cold. It has been cultivated since the beginning of the 20th century and is one of the most important forage grasses in the temperate regions of the world. It is used in pasture mixtures on wetlands and for erosion control. *Festuca pratensis* goes well with clover, *Lotus corniculatus*, alfalfa and grasses, such as *Phleum pratense* and *Dactylis glomerata*, producing a large proportion of leafy bottom growth (Stone, 2010; Maruşca et al., 2010, 2011; Ţîţei&Roşca, 2021)

The goal of the current study was to evaluate the quality of meadow fescue, *Festuca pratensis*, and the possibility of using it as feed for livestock and feedstock for the production of biomethane by anaerobic digestion.

MATERIALS AND METHODS

The cultivar *'Tâmpa'* of meadow fescue *Festuca pratensis* created in the Research-Development Institute for Grassland Brasov, Romania, and grown in monoculture on the experimental land of National Botanical Garden (Institute) Chişinău, N 46°58′25.7″ latitude and E 28°52′57.8″ longitude, served as subject of the research. The samples were collected in pre-anthesis stage (1-st cut) in the second and third growing seasons. The prepared hay was dried directly in the field. The haylage was prepared from wilted mass. For ensiling, the green mass and wilted mass were chopped into 1.5-2.0 cm pieces by using forage chopping unit, shredded and compressed in well-sealed glass containers. The dry matter content was detected by drying samples up to constant weight at 105°C. After 45 days, the containers were opened, and the sensorial and fermented indices of conserved forage were determined in accordance with Moldavian standard SM 108. Some assessments of the main biochemical parameters: protein (CP), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF), acid detergent lignin (ADL), total soluble sugars (TSS), digestible dry matter (DDM), digestible organic matter (DOM) have been evaluated using the near infrared spectroscopy (NIRS) technique PERTEN DA 7200 at the Research-Development Institute for Grassland Brasov, Romania. The concentration of hemicellulose (HC) and cellulose (Cel), relative feed value (RFV), digestible energy (DE), metabolizable energy (ME), net energy for lactation (NEl)) were calculated according to standard procedures. The carbon content of the substrates was determined using an empirical equation reported by Badger et al. (1979). The biochemical biogas potential (Yb) and methane potential (Ym) were calculated according to the equations of Dandikas et al. 2015, based on the chemical compounds – protein, acid detergent lignin (ADL) and hemicellulose (HC) values:

biogas Yb=670+0.44PB+0.16HC-3.02ADL

methane Ym=370+0.21PB+0.05HC-1.61ADL

RESULTS AND DISCUSSIONS

In the second growing season, the cultivar 'Tâmpa' of *Festuca pratensis* resumed growth and development in spring, in the middle of March, when the average temperature was about 5-6°C, but in the third growing season – at the end of March. In the spring of the third year of growth, the weather conditions, characterized by optimal amount of rainfall and air temperatures as compared with the previous year, helped the plants produce more shoots and were favorable for their growth, development and biomass production. We would like to mention that the cultivar 'Tâmpa' of *Festuca pratensis*, in second year reached 73.5 cm in height, but in the third growing season, the plants were taller – 118.9 cm. In the harvested biomass, the leaf content was 33.0-35.6%, the amount of dry matter – 25.0-29.8%.

The green mass yield at the first cut, in the second growing season, reached 3.10 kg/m^2, but in the third year – 4.07 kg/m^2.

Several literature sources have described the productivity of *Festuca pratensis.* According to Maruşca et al. (2011) the potential yields of cv. 'Tâmpa' in Romania were 45-50 t/ha green mass or 10 t/ha dry matter and 800 kg/ha seeds. Drapeau & Belanger (2009) reported that meadow fescue in monoculture had produced 4.3 t/ha DM dry matter. Berzins et al. (2015) found that studied cultivars yielded were 5.83-6.49 t/ha. Coblentz et al. (2020) revealed that the dry matter yield of meadow fescue had been 5.58 t/ha and of tall fescue – 5.76 t/ha. De Boer et al. (2020) mentioned that herbage mass of meadow fescue was 5.0 tons/acre DM.

The biochemical composition, nutritive and energy value of the green mass and hay from *Festuca pratensis* cv. 'Tâmpa' are presented in Table 1. Analysing the results of the biochemical composition of green mass, we found that the dry matter contained 112-120 g/kg CP, 361-394 g/kg CF, 78-79 g/kg ash, 374-381 g/kg ADF, 622-630 g/kg NDF, 34-38 g/kg ADL, 340-343 g/kg Cel, 241-256 g/kg HC. Digestibility is the most important factor influencing nutritive and energy value, performance of animals. In our case, the harvested mass was characterized by 59.0-61.5% DMD, 54.2-58.1% DOM, RFV=88-89, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl. The concentration of crude protein was high in the green mass harvested in the third growing season. It contained a low amount of acid detergent fibre and lignin, but a high amount of hemicellulose in green mass, in the second growing season, which have a positive effect on dry matter digestibility, relative feed value and energy content.

Table 1. The biochemical composition and nutritive value of green mass and hay from *Festuca pratensis* cv. 'Tâmpa'

Indices	Second growing season		Third growing season,	
	green mass	hay	green mass	hay
Crude protein, g/kg DM	112	125	120	113
Crude fibre, g/kg DM	394	378	361	386
Minerals, g/kg DM	78	88	79	91
Acid detergent fibre, g/kg DM	374	407	381	418
Neutral detergent fibre, g/kg DM	630	651	622	673
Acid detergent lignin, g/kg DM	34	41	38	43
Total soluble sugars, g/kg DM	-	-	133	66
Cellulose, g/kg DM	340	366	343	375
Hemicellulose, g/kg DM	256	244	241	255
Digestible dry matter, g/kg DM	615	545	590	495
Digestible organic matter, g/kg DM	581	503	542	471
Relative feed value	88	82	89	79
Digestible energy, MJ/kg	11.83	11.37	11.73	11.21
Metabolizable energy, MJ/kg	9.71	9.34	9.63	9.21
Net energy for lactation, MJ/kg	5.73	5.35	5.65	5.22

Literature sources indicate considerable variation in the chemical composition and nutritional value of harvested *Festuca pratensis* plants. According to Burlacu et al. (2002), the nutritive composition of *Festuca pratensis* was: 16.8-22.1% DM, 7.9-10.5% ash, 11.4-19.5% CP, 3.3-4.8 % fats, 21.4-30.0% CF, 43.8-47.5% NFE, 59.6-64.1% NDF, 39.6% ADF, 3.8-4.7% ADL, 31.5-37.2% Cel, 16.0% HC, 18.3-18.4 MJ/kg GE, 11.74-14.11 MJ/kg DE, 9.61-11.41 MJ/kg ME. Podkówka et al. (2011), reported that the dry matter content and the nutritive value of meadow fescue were: 300.98-310.48 g/kg DM, 82.16-86.92 g/kg CP, 21.72-23.03 g/kg fat, 291.42-311.29 g/kg CF, 534.87-542.86 g/kg NFE, 554.34-563.31 g/kg NDF, 283.58-295.93 g/kg ADF, 19.93-20.80 g/kg ADL. Sosnowski (2012) found that *Festuca pratensis* contained 32.7-35.9% ADF, 49.7-54.2% NDF, with 61.0-63.4% DMD, RFV=104-119. Guo et al. (2013) mentioned that mixed-crop 60% tall fescue and 40% meadow fescue at the first cut contained 179 g/kg DM, 20.6% CP, 54.3% NDF, 13.9% NFC and at the second cut – 291 g/kg DM, 13.9% CP, 59.5% NDF, 13.7% NFC. Berzins et al. (2015) remarked that the forage quality of first-cut green mass of *Festuca pratensis*

cultivars was 10.66-12.50% CP, 5.46-6.79% ash and RFV= 89.49-104.53, but – of second-cut– 15.27-17.13% CP, 6.97-7.49% ash and RFV=101.28-114.43, respectively. Staniak (2016) found that the tested *Festuca pratensis* cultivars, in the second year of growth, contained 146-156 g/kg CP, 286-296 g/kg CF, 73.4-75.2% DDM, 86.6-94.5% PDIE, 32.9-38.1% PDIF, 0.90-0.91 UFL, 0.84-0.86 UFV. Coblentz et al. (2020) found that the biochemical composition and nutritive value of meadow fescue fresh mass was 71 g/kg CP, 90 g/kg ash, 98.3 g/kg WSC, 609 g/kg NDF, 364 g/kg ADF, 27.5 g/kg ADL, 1.40 Mcal/kg NEl, but tall fescue – 75 g/kg CP, 82 g/kg ash, 107.3 g/kg WSC, 627 g/kg NDF, 356 g/kg ADF, 27.9 g/kg ADL, 1.40 Mcal/kg NEl, respectively. De Boer et al. (2020), mentioned that herbage mass of meadow fescue contained 11% CP and 59% NDF. Pabón-Pereira et al. (2020) reported that *Festuca pratensis* green leaves contained 482.9 g/kg NDF, 279.2 g/kg ADF, 15.2 g/kg ADL, but *Zea mays* green leaves contained 588.6 g/kg NDF, 277.3 g/kg ADF, 5.8 g/kg ADL.

Grass hay plays an important role in the diet of herbivores, represents a low-cost and abundant source of nutrients and is vital to keep animals healthy and productive. We would like to mention that the hay prepared from *Festuca pratensis* 'Tâmpa' (Table 1) contained 113-125g/kg CP, 378-386 g/kg CF, 88-91 g/kg ash, 407-418 g/kg ADF, 651-673 g/kg NDF, 41-43 g/kg ADL, 366-375 g/kg Cel and 244-255 g/kg HC. The nutritive value and the energy value of the hay were 59.0-61.5% DMD, 54.2-58.1% DOM, RFV=88-89, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl. The amounts of minerals, crude fibre, cellulose, hemicellulose and lignin increased substantially in the hay obtained in the third year, which contributed to the reduction of dry matter digestibility, relative feed value and energy content. During the process of preparing hay, we observed an increase in the concentration of structural carbohydrates, lignin, minerals and a decrease in the total soluble sugars content, dry matter digestibility and relative feed value and energy concentration as compared to green mass.

Some authors mentioned various findings about the quality of fescue hay. Burlacu et al. (2002) reported that *Festuca pratensis* hay contained: 8.5-11.5% ash, 10.0-18.2% CP, 2.8-4.1% fats, 22.5-32.0% CF, 43.7-46.7% NFE, 18.1-18.2 MJ/kg GE. Akdeniz et al. (2019), reported that the dry biomass yield and nutritional quality of tall fescue hay, in the second year, were: 10.23 t/ha, 9.54% ash, 9.86% CP, 1.15% fats, 44.85% CF, 64.05% NDF, 47.64% ADF, RFV=75.22 and of creeping red fescue hay – 4.34 t/ha, 8.94% ash, 8.85% CP, 1.44% fats, 43.61% CF, 69.25% NDF, 44.26% ADF, RFV=71.11.

The management of forage as silage provides the opportunity to harvest the crop at a desired level of digestibility for subsequent feeding. Silage production minimizes the risk associated with field losses, which can be incurred under rainy conditions during hay making. Wilting herbage prior to ensiling has many advantages including reducing effluent production and fuel consumption, improved characteristics of ensiling, reduced quantities of silage for transport during feed out and reduced straw requirement for bedding livestock. Grass, when harvested and stored as silage and haylage, is an important source of nutrients for livestock, is a great way to preserve nutrients for autumn - middle spring, a period when grasslands are less productive. When opening the glass vessels with fermented fodder, silage and haylages, prepared from *Festuca pratensis* cv. 'Tâmpa' in the third growing season, there was no gas or juice leakage from the preserved mass. The fodder had agreeable colour and aroma, the consistency was retained, in comparison with the initial green mass, without mould and mucus. During the sensorial assessment, it was found that the colour of the silage was dark green leaves and light green stems with pleasant smell specific to pickled vegetables, but haylage – homogeneous yellow-olive colour with pleasant smell like pickled fruits. The fermentation quality, biochemical composition and nutritive value of silage and haylage from *Festuca pratensis* cv. 'Tâmpa' is shown in Table 2. It has been determined that the pH index was 4.06-4.23, the concentrations of organic acids reached 37.6-39.2 g/kg, and most amounts of organic acids were in fixed form. The content of lactic acid increased in haylage. Butyric acid not was detected in the fermented fodder.

Table 2. The fermentation quality, biochemical composition and nutritive value of silage and haylage from meadow fescue, *Festuca pratensis* cv. 'Tâmpa'

Indices	Silage	Haylage
pH index	4.06	4.23
Content of organic acids, g/kg	37.6	39.2
Free acetic acid, g/kg	3.7	3.9
Free butyric acid, g/kg	0	0
Free lactic acid, g/kg	8.5	6.9
Fixed acetic acid, g/kg	4.4	4.1
Fixed butyric acid, g/kg	0	0
Fixed lactic acid, g/kg	21.0	24.3
Crude protein, g/kg DM	119	106
Crude fibre, g/kg DM	380	399
Minerals, g/kg DM	96	89
Acid detergent fibre, g/kg DM	402	414
Neutral detergent fibre, g/kg DM	679	677
Acid detergent lignin, g/kg DM	28	31
Total soluble sugars, g/kg DM	76	68
Cellulose, g/kg DM	374	383
Hemicellulose, g/kg DM	277	263
Digestible dry matter, g/kg DM Digestible	622	569
organic matter, g/kg DM	535	492
Relative feed value	79	78
Digestible energy, MJ/ kg	11.45	11.27
Metabolizable energy, MJ/ kg	9.40	9.25
Net energy for lactation, MJ/ kg	5.41	5.28

Analyzing the results regarding the quality of fermented fodder from *Festuca pratensis* cv. 'Tâmpa', in the third growing season, Table 2, we found that the dry matter of fermented fodder was characterized by 106-119 g/kg CP, 380-399 g/kg CF, 89-96 g/kg ash, 402-414 g/kg ADF, 677-679 g/kg NDF, 28-31 g/kg ADL, 68-76 g/kg TSS, 374-383 g/kg Cel, 402-414 g/kg HC, with nutritive and energy value 56.9-62.2% DMD, 49.2-53.5% DOM, RFV=78-79, 11.27-11.45 MJ/kg DE, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl. There was a significantly higher content of crude protein, total soluble sugars, hemicellulose and energy concentration in the prepared silage.

According to Smith et al. (1987), the nutrient concentration and fermentation characteristics of fescue haylage were 479 g/kg DM, 10.5% ash, 15.5% CP, 3.8% fats, 44.7% nitrogen-free extract, 45.7% NDF, 25.5% ADF, 3.2% ADL, 3.1% WSC with 69% DMD, pH=4.3, 3.22 % lactic acid, 1.52 % acetic acid, 0.10% butyric acid. Burlacu et al. (2002), reported that *Festuca pratensis* silages contained: 18.5-24.5% DM, 8.0-10.5% ash, 13.5-17.5% CP, 4.7-5.7% fats, 23.8-27.9% CF, 43.0-45.3% NFE, 18.6-18.8 MJ/kg GE, 11.59-12.99 MJ/kg DE, 9.09-10.40 MJ/kg ME, but haylage (wilting silage) 35.0% DM, 8.4-10.9% ash, 11.5-15.7% CP, 3.5-5.4% fats, 25.0-30.6% CF, 43.0-46.0% NFE, 18.3-18.4 MJ/kg GE, 11.55-12.84 MJ/kg DE, 9.45-10.46 MJ/kg ME. Pozdíšek et al. (2003) mentioned that the chemical composition and energy value of silage from *Festuca arundinacea* were 118.5 g/kg CP, 33.8 g/kg fat, 261.9 g/kg CF, 477.4 g/kg NFE, 528.9 g/kg NDF, 308.6 g/kg ADF, 108.4 g/kg ash, 9.54 MJ/kg ME, 5.65 MJ/kg NEl. Muller& Uden (2007) compared the quality of conserved grass from permanent grassland consisting of timothy grass, meadow fescue, and a small proportion (0.1%) of couch grass, *Agropyron repens*, found that the prepared silage had pH=4.3 and contained 31.8 g/kg lactic acid, 6.6 g/kg acetic acid, 1.0 g/kg butyric acid, 309 g/kg DM, 11.3% CP, 6.6% ash, 58.5% NDF, 2.6% WSC, 77% DMD, 9.7 MJ/kg ME for horses; the haylage had pH=5.63 and contained 2.6 g/kg lactic acid, 1.4 g/kg acetic acid, 0.4 g/kg butyric acid, 577 g/kg DM, 10.8% CP, 6.4% ash, 60.8% NDF, 6.9% WSC, 74% DMD, 9.4 MJ/kg ME for horses; the hay contained 884 g/kg DM, 11.3 % CP, 6.6% ash, 60.5% NDF, 10.1% WSC, 77% DMD, 9.8 MJ/kg ME for horses. Kuoppala et al. (2009) remarked that the chemical composition and the feed value of silage prepared from mixed timothy

grass and meadow fescue were: 283 g/kg DM, 6.8-8.2% ash, 12.7-15.5% CP, 49.8-58.9% NDF, 5.0-9.7% iNDF, 44.8-49.2 pdNDF, 2.3-2.7% lignin, pH=3.97-4.22, 6.84% lactic acid, 1.31-1.74% acetic acid, 0.13-0.48% butyric acid with 64.4-70.4% DOM and 10.3-11.3 MJ/kg ME. Guo et al. (2013) mentioned that ensiled fescue first-cut fresh mass contained 178 g/kg DM, 18.7 % CP, 47.2% NDF, 22.8% NFC, pH=4.84, 5.59% lactic acid, 4.59% acetic acid, but ensiled fescue wilted forages contained 26.4-44.7 g/kg DM, 19.8-20.2% CP, 46.6-47.4% NDF, 21.4-22.4% NFC, pH=4.93-5.10, 2.95-4.25% lactic acid, 1.23-2.54% acetic acid. Purwin et al. (2014) mentioned that red fescue silage from wilted mass contained: 437-485 g/kg DM, 16.5-17.0 g/kg total nitrogen, 598-617 g/kg NDF, 408-410 g/kg ADF, 62-65 g/kg ADL, 345-346 g/kg Cel, 190-207 g/kg HC. Kupryś-Caruk & Kołodziejski (2016) reported that the dry matter content and the chemical composition of silages from *Festuca arundinacea* were 214 g/kg DM, pH=5.2, 89.7 g/kg lactic acid, 2.3 g/kg acetic acid, 10.8% CP, 11.7% ash, 2.3% fats, 5.0% sugars, 3.0% ADL, 30.4% Cel, 5.7% HC. Coblentz et al. (2020) compared the feed quality and the energy value of silage from different species of fescue and mentioned that *Festuca pratensis* silage contained 77 g/kg CP, 97 g/kg ash, 51.4 g/kg WSC, 644 g/kg NDF, 391 g/kg ADF, 30.1 g/kg ADL, 1.34 Mcal/ kg NEl, 21.7 g/kg lactic acid, 7.6 g/kg acetic acid, 3.0 g/kg butyric acid, but *Festuca arundinacea* – 85 g/kg CP, 91 g/kg ash, 74.7 g/kg WSC, 649 g/kg NDF, 366 g/kg ADF, 26.9 g/kg ADL, 1.37 Mcal/ kg NEl, 16 g/kg lactic acid, 8.2 g/kg acetic acid, 2.4 g/kg butyric acid. Müller et al. (2020) remarked the nutritive value of a grass mixture, consisting of *Phleum pratense*, *Lolium perenne* and *Festuca pratensis* conserved in big round bales, which was as follows: 12.6% CP, 9.6% ash, 10.7% WSC and 9.9 MJ/kg ME for horses.

Replacing fossil fuels with renewable energy alternatives has become a major global issue of the 21th century and a key to sustainable development. Anaerobic digestion is dedicated to the use of organic waste as a source for renewable energy, though often combined with energy crops as input material. However, in order to consolidate the role of biogas production via anaerobic digestion as a renewable energy production technology, it is important to ensure the availability of sustainable biomass sources, because installations do not only produce energy but also digestate, which is rich in organic matter and plant nutrients such as nitrogen, phosphate and potash, and could serve as a replacement for fossil based fertilizers. The biodegradation of different types of lignocellulosic biomass feedstock depends on the chemical structure, primarily on the content of cellulose, hemicellulose, lignin and the C/N ratio. The carbon nitrogen ratio (C/N) of biomass plays a crucial role in the process of decomposition of organic matter by microorganisms. Mowed grass can be processed conveniently into an attractive feedstock for biogas production. Good ensiling, where lactic acid production dominates the fermentation, will efficiently conserve grass as a feedstock for anaerobic digestion. Ensiled grass may provide a year-round supply of feedstock for biogas production facilities.

The results regarding of the substrate quality and its biochemical methane potential are illustrated in Table 3. We found that the investigated substrates from *Festuca pratensis* cv. 'Tâmpa', according to the C/N ratio, which constituted 26-30, met the established standards. The essential differences were observed between the content of cellulose, hemicellulose and lignin. The silage and haylage substrates contained high amount of hemicellulose and reduced lignin content, compared with green mass substrates. The biochemical methane potential of investigated green mass substrates was 346-352 l/kg ODM, but – from silage and haylage substrates – 355-362 l/kg ODM. According to Mähnert et al. (2002), *Festuca pratensis* 'Cosmos11' fresh mass substrate contained 176 g/kg DM, 91.5% OM, pH= 6.4 with biogas yield 708 l/kg and silage substrate – 274 g/kg DM, 89.9% OM, pH=4.7, 887 l/kg, but *Festuca arundinacea* 'Elfina' fresh mass substrate contained 139 g/kg DM, 89.1% OM, pH=6.4 with biogas yield 688 l/kg and silage substrate – 173 g/kg DM, 89.6% OM, pH=4.0 with biogas yield 887 l/kg, respectively. Jagadabhi et al. (2010) found that the ensiled grass mixture 75% *Phleum pratense* and 25% *Festuca pratensis* biomethane yield

achieved 400 l/kg VS. Kaiser & Gronauer (2007) mentioned that the methane potential of studied red fescue varieties was 280–335 l/kg or 3800–5300 m^3/ha. Kupryś-Caruk & Kołodziejski (2016) indicated that the biogas potential of fescue silage was 734.1 m^3/t with 55% methane content.

Table 3. The biochemical composition and biomethane production potential of *Festuca pratensis* cv. 'Tâmpa' substrates

Indices	Second growing season	Third growing season		
	green mass	green mass	silage	haylage
Crude protein, g/kg DM	112	120	119	106
Minerals, g/kg DM	78	79	96	89
Nitrogen, g/kg DM	17.92	19.20	19.04	16.96
Carbon, g/kg DM	512.22	511.67	502.22	506.11
Carbon/nitrogen ratio	28.58	26.65	26.38	29.84
Cellulose, g/kg DM	340	343	374	383
Hemicellulose, g/kg DM	256	241	277	263
Acid detergent lignin, g/kg DM	34	38	28	31
Biomethane potential, L/kg VS	352	346	363	355

CONCLUSIONS

The green mass yield of *Festuca pratensis* cv. 'Tâmpa' reached 3.10-4.07 kg/m^2, the dry matter of harvested green mass contained 112-120 g/kg CP, 361-394 g/kg CF, 78-79 g/kg ash, 374-381 g/kg ADF, 622-630 g/kg NDF, 34-38 g/kg ADL, 340-343 g/kg Cel, 241-256 g/kg HC, with nutritive and energy value 59.0-61.5% DMD, 54.2-58.1% DOM, RFV=88-89, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl.

The biochemical composition, the nutritive and energy value of the prepared hay has the following indices: 113-125 g/kg CP, 378-386 g/kg CF, 88-91 g/kg ash, 407-418 g/kg ADF, 651-673 g/kg NDF, 41-43 g/kg ADL, 366-375 g/kg Cel and 244-255 g/kg HC, 9.0-61.5% DMD, 54.2-58.1% DOM, RFV=88-89, 9.63-9.71 MJ/kg ME and 5.65-5.73 MJ/kg NEl.

The fermented fodder, silage and haylage, from *Festuca pratensis* 'Tâmpa', is characterized by pH = 4.06-4.23, 8.0-8.1 g/kg acetic acid, 29.5-31.2 g/kg lactic acid, 106-119 g/kg CP, 380-399 g/kg CF, 89-96 g/kg ash, 402-414 g/kg ADF, 677-679 g/kg NDF, 28-31 g/kg ADL, 68-76 g/kg TSS, 374-383 g/kg Cel, 402-414 g/kg HC, with nutritive and energy value 56.9-62.2% DMD, 49.2-53.5% DOM, RFV=78-79, 11.27-11.45 MJ/kg DE, 9.63-9.71 MJ/kg ME, 5.65-5.73 MJ/kg NEl.

The biochemical methane potential of green mass substrates achieved 346-352 l/kg ODM, silage substrate – 362 l/kg ODM and haylage substrates – 355 l/kg ODM.

Under the conditions of the Republic of Moldova, cv. 'Tâmpa' of *Festuca pratensis* produces optimal yield and nutrient content, can be used to re-cultivate permanent grasslands and to establish temporary grasslands in order to prevent soil erosion, in monoculture or associated with other grasses and forage legume, and the harvested mass can be used as green mass, hay, silage and haylage for livestock, or as a substrate for the production of biomethane and renewable energy.

ACKNOWLEDGEMENTS

The study has been carried out in the framework of the project: 20.80009.5107.02 *"Mobilization of plant genetic resources, plant breeding and use as forage, melliferous and energy crops in bioeconomy"*

REFERENCES

Akdeniz, H., Hosaflioğlu, I., Koç, A., Hossain, A., Islam, M.S., Iqbal, M. A., Imtiaz, H., Gharib, H., El Sabagh, A. (2019). Evaluation of herbage yield and nutritive value of eight forage crop species. *Applied Ecology and Environmental Research, 17*(3), 5571–5581.

Berzins, P., Jansone, S., Rancane, S., Stesele. V., Dzene, I. (2015). The evaluation of perennial grass cultivars in Latvia condition. *Proceedings of the 25th NJF congress Nordic View to Sustainable Rural Development*, 141–147.

Burlacu, G., Cavache, A., Burlacu R. (2002). *Potentialul productiv al nutreturilor si utilizarea lor*. București, Ceres. 501.

De Boer, M., Grev, A., Sheaffer, C., Wells, M., Martinson, K.L. (2020). Herbage mass, botanical composition, forage nutritive value, and preference of grass-legume pastures under horse grazing. *Crop,*

Forage and Turfgrass Management. 6. 10.1002/cft2.20032.

Drapeau, R., Belanger, G. (2009). Comparison of meadow fescue and meadow bromegrass in monoculture and in association with white clover. *Canadian Journal of Plant Science*, *89*. 1059–1063.

Coblentz, W.K., Akins, M.S., Cavadini, J.S., (2020). Fermentation characteristics and nutritive value of baled grass silages made from meadow fescue, tall fescue, or an orchardgrass cultivar exhibiting a unique nonflowering growth response. *Journal of Dairy Science*, *103*(4), 3219–3233.

Guo, X., Undersander, D., Combs, D. (2013). Effect of Lactobacillus inoculants and forage dry matter on the fermentation and aerobic stability of ensiled mixed-crop tall fescue and meadow fescue. *Journal of Dairy Science*, *96*. 1735–1744.

Jagadabhi, P.S., Kaparaju, P., Rintala, J. (2010). Effect of micro-aeration and leachate replacement on COD solubilization and VFA production during monodigestion of grass-silage in one-stage leach-bed reactors. *Bioresource Technology*, *101*(8), 2818–2824.

Kaiser, F., Gronauer, A. (2007). *Methanproduktivität nachwachsender Rohstoffe in Biogasanlagen* Bayerische Landesanstalt für Landwirtschaft, 24p. https://www.lfl.bayern.de/mam/cms07/publikationen/daten/informationen/p_27455.pdf

Kuoppala, K., Rinne, M., Ahvenjärvi, S., Nousiainen, J., Huhtanen P. (2010). The effect of harvesting strategy of grass silage on digestion and nutrient supply in dairy cows. *Journal of Dairy Science*, *93*(7), 3253–3263.

Kupryś-Caruk, M., Kołodziejski, R. (2016). Effectiveness of biogas production from C3 (*Festuca arundinacea* Schreb.) and C4 (*Spartina pectinata* L.) perennial grasses. *Journal of Research and Applications in Agricultural Engineering*, *61*(1), 44–47.

Mähnert, P., Heiermann, M., Pöchl, M., Schelle, H., Linke, B. (2002). Verwertungsalternativen für Grünlandbestände – Futtergräser als Kosubstrat für die Biomethanisierung. *Landtechnik*, *5*. 260–261.

Maruşca, T., Mocanu, V., Cardaşol, V., Hermenean, I., Blaj, V.A., Oprea, G., Tod, M.D. (2010). Ghid de producere ecologică a furajelor de pajişti montane. Braşov.178.

Maruşca, T., Tod, M., Silistru, D., Dragomir, N., Schitea, M. (2011). *Principalele soiuri de graminee şi leguminoase perene de pajişti.* Braşov. Capolavoro, 52.

Müller, C.E, Johansen, A. (2020). Rebaling of silage and haylage and its effects on forage microbial and chemical composition—A pilot study. *Grass and Forage Science*, *75*. 216–226.

Muller, C.E., Uden, P. (2007) Preference of horses for grass conserved as hay, haylage or silage. *Animal Feed Science and Technology*, *132*. 66–78.

Pabón-Pereira, C.P., Hamelers, H.V.M., Matilla, I., van Lier, J.B. (2020). New insights on the estimation of the anaerobic biodegradability of plant material: identifying valuable plants for sustainable energy production. *Processes*, *8*. 806. https://doi.org/10.3390/pr8070806

Podkówka L., Dorszewski, P., Pańka, D. (2011). Yield, chemical composition and ensiling ability of green forage from meadow fescue (*Festuca pratensis* Huds.) infected with *Neotyphodium uncinatum*. *Acta Scientiarum Polonorum Agricultura*, *1*. 47–56.

Pozdíšek, J., Loučka, R., Machacova, E. (2003). Digestibility and nutrition value of grass silages. *Czech Journal of Animal Science*, *48*. 359–364.

Purwin, C., Fijałkowska, M., Kowalik, B., Skórko-Sajko, H., Nogalski, Z., Pysera, B. (2014). The effect of bale density and addition of formic acid on the in situ dry matter and crude protein degradation of lucerne, red clover and red fescue silages. *Journal of Animal and Feed Sciences*, *23*. 177–184. 10.22358/jafs/65707/2014.

Smith, W. L., Gay, N., Boling J. A., Muntifering, R. B. (1987). Growth and metabolism of growing beef calves fed tall fescue haylage supplemented with protein and(or) energy. *Journal of Animal Science*, *65*(4), 1094–1100. https://doi.org/10.2527/jas1987.6541094x

Sosnowski, J. (2012). Effect of soil's fertilizer used in cultivation *Lolium perenne* L., *Dactylis glomerata* L. and *Festuca pratensis* Huds. on relative value (RFV) of food. *Fragmenta Agronomica*, *29*(3), 136–143 [In Polish].

Staniak M. (2016). The impact of drought stress on the yields and food value of selected forage grasses. *Acta Agrobotanica*, *69*(2), 1663. http://dx.doi.org/10.5586/aa.1663

Ţîţei, V., Roşca, I. (2021). *Bunele practici de utilizare a terenurilor degradate în cultivarea culturilor cu potenţial de biomasă energetică*. Chişinău, 80.

Stone, K.R. (2010). *Schedonorus pratensis*. In: Fire Effects Information System, [Online]. https://www.fs.fed.us/database/feis/plants/graminoid/schpra/all.html

* SM 108:1995 (1996). Siloz din plante verzi. Condiţii tehnice. Moldovastandart. 10.