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THE AGROECONOMIC VALUE OF COMMON MILLET, *PANICUM MILIACEUM*, UNDER THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

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Abstract

Common millet, Panicum miliaceum, is one of the world's oldest cultivated crops. This research was aimed at evaluating the quality indices of fodders and substrates for biomethane production from common millet crop. The cultivar 'Marius' of Panicum miliaceum, created at the National Agricultural Research and Development Institute Fundulea, Romania, cultivated in the experimental sector of the "Alexandru Ciubotaru" National Botanical Garden (Institute) MSU Chişinău served as subject of the research. The results revealed that the dry matter of Panicum miliaceum 'Marius' whole plants contained: 10.62% CP, 2.81% EE, 30.96% CF, 47.60% NFE, 8.01 % ash, 0.30% Ca, 0.23% P with 18.21 MJ/kg GE, 9.29 MJ/kg ME and 5.23 MJ/kg NEl. The prepared silage is characterized by pleasant smell and color, the dry matter nutrient and feed energy values were: 11.07% CP, 4.01% EE, 36.65% CF, 38.61% NFE, 9.66 % ash with 18.38 MJ/kg GE, 8.61MJ/kg ME, 4.69 MJ/kg NEl. The common millet hay contained 13.40% CP, 2.37% EE, 32.22% CF, 42.29% NFE, 9.72 % ash with 18.02 MJ/kg GE, 8.66 MJ/kg ME, 4.84 MJ/kg NEl. The common millet substrates for anaerobic digestion for renewable energy production had optimal carbon to nitrogen ratio and the estimated biochemical methane potential reached 303-305 l/kg organic matter. The Panicum miliaceum 'Marius' grain contained 140.0g/kg CP, 47.5 g/kg EE, 137.0 g/kg CF, 627.4 g/kg NFE, 48.0 g/kg ash, 0.9 g/kg Ca and 0.6g/kg P. The cultivar is characterized by optimal productivity, can be used in monoculture or as a component of the mix of annual legume crops, and the harvested green mass may be used as forage for livestock as natural fodder, hay, fermented fodders, also as substrate in biogas reactors via anaerobic digestion for renewable energy production.

Key words**:** *biochemical composition, biomethane potential, grain, green mass, hay, nutritive value, Panicum miliaceum 'Marius', silage*

INTRODUCTION

A solution to a lot of problems associated with food security, healthcare and raw material supply for industrial purposes would be the diversification of crops by cultivating neglected and underused crops on a larger scale, as well as new species.

Global warming and altering precipitation patterns affect crop water requirements, cause a decrease in crop productivity, while raising the cost of irrigation. Under these conditions, switching to alternative crops that require minimal water input, are tolerant to abiotic stress, provide high yields may be an effective measure of coping with water scarcity in agriculture.

In particular, sorghum and millet crops are gaining popularity due to their high resilience against the effects of climate change and acceptable productivity and nutritional value. *Panicum* L. is a genus in the family Poaceae, with nearly 450 species of annual or perennial grasses, occurring in areas with tropical and warm temperate climate. Many representatives of this genus are popular agricultural and horticultural crops, due to their economic significance and ornamental value.

Panicum miliaceum L. is one of the most commonly cultivated millet species as grain and forage crops. This species, commonly known as proso millet or common millet, is one of the world's oldest cultivated crops, and has also been cultivated in our region. It is a summer annual plant, the stems are light green, erect, sometimes branched at the base, and grow 0.5-1.5 m tall, with bright green leaves, compact panicle, the grains are round, about 3 mm long and 2 mm wide, and

enclosed in a smooth hull, which is typically white or creamy-white, yellow, or red, but also may be gray, brown or black. Plants have shallow, fibrous root systems and produce few tillers. It is a short growing, summer season crop (60 to 100 days) with unique agronomic properties such as high tolerance to heat and drought conditions. *Panicum miliaceum* could be a viable alternative to main summer forages in areas where cultivation of corn or Sudan grass is restricted because of a longer growing season or poor agricultural conditions [10; 13; 16; 23; 24; 27, 28; 20].

The goal of this research was to evaluate the quality indices of the harvested green mass, prepared silage and hay, collected grain from common millet, *Panicum miliaceum*, for feeding farm animals, as well as substrates for anaerobic digestion of the production of biomethane as renewable energy.

MATERIALS AND METHODS

The cultivar *'Marius'* of common millet, *Panicum miliaceum*, created at the National Agricultural Research and Development Institute Fundulea, Romania, cultivated in the experimental sector of the "Alexandru Ciubotaru" National Botanical Garden (Institute) Chişinău served as subject of the research. The cultivar *'Napoca 2'* of tall fescue *Festuca arundinacea* created at the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, România, hybrid *"SAŞM-4"* of sorghum and Sudan grass – *Sorghum bicolor* × *Sorghum sudanense* – created at the Institute of Genetics, Physiology and Plant Protection of Republic of Moldova and the hybrid *'Porumbeni 374'* of corn, *Zea mays*, created at the Institute of Crop Science "Porumbeni", Republic of Moldova, were used as control variants. The proso millet, tall fescue and sorghum x Sudan grass hybrid plant samples were collected in the pre-flowering stage and corn – in wax stage of grains. The prepared hay from proso millet and tall fescue was dried directly in the field. The silage was prepared from green mass cut into small pieces, compressed in well-sealed glass containers, stored at ambient temperature (18-20 °C) for 45 days, to allow complete fermentation to occur. Following the 45-day fermentation period, each glass container was opened and the content was visually examined, the color and the aroma were recorded. The dry matter content was detected by drying samples up to constant weight at 105°C. For biochemical analysis, the samples were dried in a forced air oven at 60°C, milled in a beater mill equipped with a sieve with diameter of openings of 1 mm. The pH of the samples of silage was measured immediately after removal from the containers. After seed formation, proso millet panicles from five plants on each plot were protected with paper bag to prevent grain loss. Hand-harvesting was carried out at full maturity, the common millet panicles were threshed and the grains were cleaned by sieves and a wind separation system. The evaluation of chemical composition: crude protein (CP), crude fat (EE), crude cellulose (CF), nitrogen-free ex-tract (NFE), soluble sugars, starch, ash, calcium (Ca), phosphorus (P), carotene content were carried out in the Laboratory of Nutrition and Forage Technology of the Scientific-Practical Institute of Biotechnology in Animal Husbandry and Veterinary Medicine, in accordance with the methodological indications. The gross energy (GE), metabolizable energy (ME) and net energy for lactation (NEl) were calculated according to standard procedures.

The carbon content of the substrates was determined using an empirical equation according to Badger et al. [3]. The biochemical biomethane potential was calculated using the methane potential of degradable nutrients according to Baserga [4], and the digestibility index of nutrients – according to Medvedev & Smetannikova [16], Coșman et al. [9].

RESULTS AND DISCUSSIONS

The biochemical composition and fodder value of the green mass from *Panicum miliaceum* 'Marius' are presented in Table 1. The comparative analysis of the nutrient concentration of the harvested green fodder showed that common millet fodder was

characterized by a significantly higher content of proteins than sorghum x Sudan grass and corn green mass fodders. The level of crude fat content in whole plants of the studied species did not differ significantly. The content of crude cellulose in common millet green fodder was lower than in sorghum x Sudan grass and tall fescue fodder, but higher than in corn whole plants. The common millet green fodder is characterized by optimal amount of nitrogen free extract, but much lower than in corn whole plants. In common millet, the ash content is lower than in tall fescue, but there is a much higher concentration of ash, calcium and phosphorus than in sorghum x Sudan grass and corn fodder. The energy supply of the feed from whole common millet plants reached 9.29 MJ/kg metabolizable energy and 5.23 MJ/kg net energy for lactation, being higher than in the forage produced from sorghum x Sudan grass and tall fescue plants, but lower than in corn plants. It was found that the level of carotene in common millet green mass was significantly higher as compared with corn green mass.

Different results regarding the biochemical composition and the nutritive value of the harvested mass from millets species are given in the specialized literature. Burlacu et al. [8] indicated that the green forage from *Panicum miliaceum* plants contained 230 g/kg DM with 91.3% OM, 14.0 % CP, 4.7% EE, 27.1% CF, 45.5% NFE and 18.5 MJ/kg GE, but *Sorghum bicolor* × *Sorghum sudanense* green mass 200 g/kg DM, 90.0% OM, 9.4 % CP, 3.1 % EE, 29.7% CF, 47.8% NFE and 17.8 MJ/kg GE, respectively. Piłat et al. [20] reported that the forage quality of *Panicum virgatum* was 274.9 g/kg DM, 92.84% OM, 10.46 % CP, 32.60% CF, 48.30% NFE, 72.33% NDF, 39.23% ADF. Avetisyan [1] revealed that the dry matter content and the nutritive value of green mass from proso millet was 200 g/kg DM, 9.8% CP, 38.9% CF, 6.2% sugar, 9.7 MJ/kg ME and from Sudan grass 250 g/kg DM, 7.6% CP, 30.5% CF, 8.0% sugar, 8.8 MJ/kg ME, respectively. Mohajer et al. [17] mentioned that the common millet whole plants contained 134.8 g/kg DM, 8.88% CP, 43.28% CF, 6.81% WSC, 29.48% ADF and 64.24% DMD [14]. Svirskis [22] reported that the forage quality of harvested common millet cultivars was characterized by the following indices 12.6-19.6 % CP, 28.0-35.6% CF, 56.6-65.3% NDF, 25.3-33.1% ADF, 4.56-11.39 % WSC and 48.4-65.3% DMD.

Zhang et al. [28] revealed that the forage produced from proso millet whole plants harvested at 12 weeks after emergence contained 12.8% CP, 73.3% NDF, 40.8% ADF; while maize forage contained 10.8% CP, 66.1% NDF, 42.89% ADF and Sudan grass forage – 12.0% CP, 62.7% NDF and 42.8% ADF, respectively.

Kertikov & Kertikova [13] stated that forage productivity of true millet *Panicum miliaceum* as non-traditional forage crop was 541.8 kg/da dry matter and crude protein feed is equal to 57.1 kg/da.

Tran [24] revealed that *Panicum miliaceum* aerial part contained 7.9% ash, 10.1% CP, 73.7 % NDF, 36.0% ADF, 4.5 % lignin, 3.6 g/kg Ca, 1.6 g/kg P, 58.5 % DOM. Maksimova et al. [15] determined that forage quality indices of *Panicum miliaceum* cv. *Baganskoye 88* was 0.56 feed units/kg DM, 107.17-126.23 g/kg DM digestible protein, 8.3-8.4 MJ/ kg DM metabolic energy, 17.5-17.6 MJ/ kg DM gross energy.

Avetisyan et al. [2] mentioned that the nutritive value of forage from studied cultivars of *Panicum miliaceum* was 0.23 feed units/kg fresh mass, 24 g digestible protein/kg fresh mass, and 10.3-10.4 MJ/kg DM exchange energy, while that from *Avena sativa* plants - 0.21 feed units /kg fresh mass, 23 g digestible protein/kg fresh mass, 10.0 MJ/kg DM exchange energy.

Park et al. [18] reported that feed values of green forage from *Panicum miliaceum* cv. *Native* was 5.7-10.4% CP, 63.1-65.4 % NDF, 36.3-37.0% ADF, 59.7-60.2% TDN and RVF=86-89, but feed values of green forage from *Panicum coloratum*, cv. *Selection*, respectively 12.0-12.4% CP, 57.8-62.2 % NDF, 30.3-31.7% ADF, 63.9-64.9% TDN and RVF=95-105.

Van Die & Entz [26] indicated that the nutritional value of forage biomass from *Panicum miliaceum* cv. Crown Proso was 8.0-10.0 % CP and 64.8%TDN, while that from

Zea mays 6.0-6.7 % CP and 65.1-69.2%TDN, but from *Sorghum bicolor* × *Sorghum sudanense* plants 4.7-4.8 % CP and 63.3-64.3% TDN.

Table 1. The biochemical composition and the fodder value of the green mass from the studied *Poaceae* species

Indices	*Panicum miliaceum*	*Festuca arundinacea*	*Sorghum bicolor* × *Sorghum sudanense*	*Zea mays*
Crude protein, % DM	*10.62*	*10.81*	*8.47*	*7.26*
Crude fats, % DM	*2.81*	*2.67*	*2.75*	*2.83*
Crude cellulose, % DM	*30.69*	*32.79*	*37.61*	*18.40*
Nitrogen free extract, % DM	*47.60*	*40.64*	*45.19*	*67.92*
Soluble sugars, % DM	*7.31*	*6.30*	*10.56*	*7.55*
Starch, % DM	*2.67*	*1.97*	*1.50*	*22.79*
Ash, % DM	*8.01*	*13.09*	*5.99*	*3.59*
Calcium, % DM	*0.30*	*0.30*	*0.20*	*0.24*
Phosphorus, % DM	*0.23*	*0.25*	*0.13*	*0.22*
Gross energy, MJ/ kg DM	*18.21*	*17.34*	*18.27*	*18.46*
Metabolizable energy, MJ/ kg DM	*9.29*	*8.96*	*8.13*	*11.13*
Net energy for lactation, MJ/ kg DM	*5.23*	*5.01*	*4.63*	*6.34*
Carotene, mg/kg	*32.92*	*28.35*	*32.92*	*14.30*

Source: Own calculation.

The hay yield and its nutritional value mainly depends on the botanical family, species and varieties, the growing period at which these plants have been harvested, on haymaking equipment, on conditions of its storage and on many other factors. Analysing the results regarding the biochemical composition of the hay prepared from proso millet and tall fescue, Table 2, we would like to mention that its dry matter contained: 10.06-13.40 % CP, 2.37-2.79% EE, 32.22-33.79% CF, 40.15-42.29% NFE, 9.72-13.25% ash, 0.23-0.32% Ca and 0.22-0.27% P with 17.33-18.02 MJ/kg GE. The hay prepared from common millet, *Panicum miliaceum*, is characterized by high level of crude protein, nitrogen free extract, calcium, phosphorus and low level of crude fats, crude cellulose, ash, but optimal gross energy value. Several literature sources describe the quality of the hay prepared from *Panicum* species. Burlacu et al. [8] mentioned that the quality indices of the hay prepared from millet plants harvested after flowering stage were: 850 g/kg DM, 92.6% OM, 5.8% CP, 2.1% EE, 33.5% CF, 51.2% NFE and 17.9 MJ/kg GE.

Berhane et al. [7] reported forage quality of hay from *Panicum miliaceum* was 17.3% CP, 72.5 % NDF, 37.4% ADF, 2.2% ADL, but hay from *Panicum coloratum* respectively 11.4% CP, 83.5 % NDF, 35.9% ADF, 2.8% ADL. Dağtekin et al. [10] mentioned that the quality indices of the hay prepared from millet plants was 16.3-20.5% CP, 28.7-36.3% ADF, 60.0-70.6 % NDF, 0.373 - 0.434% P, 0.58 - 0.824% Ca, 0.270-0.393 % Mg, 3.174- 3.964% K.

Tan et al. [23] reported that *Panicum miliaceum* hay obtained in variant without fertilization contained 12.39% CP, 58.40% NDF, 36.05% ADF, but in the variants with the application of different doses of nitrogen fertilizers, the respective values were obtained: 13.16-14.24 % CP, 58.09-60.02 % NDF, 35.73-36.10 % ADF.

Jimoh et al. [12] mentioned that the nutrient content of *Panicum maximum* forage was 9.70-9.88% CP, 7.88-8.90% EE, 47.63-54.11 % ADF, 65.44-73.58% NDF, 17.80- 19.27 HC, 41.47-45.02% Cel, 9.19- 9.58% ash.

Tran [24] reported that dry matter concentration of nutrients and fodder value of hay from common millet plants were 7.9% ash, 12.5% CP, 2.5% EE, 33.9% CF, 72.3 % NDF, 39.9% ADF, 5.9 % lignin, 6.6% ash, 59.3% DOM, 18.9 MJ/kg GE, 10.7 MJ/kg DE, 8.6 MJ/kg ME.

Table 2. The biochemical composition and the fodder value of the hay from the studied *Poaceae* species

Indices	***Panicum miliaceum***	***Festuca arundinacea***
Crude protein, % DM	*13.40*	*10.06*
Crude fats, % DM	*2.37*	*2.79*
Crude cellulose, % DM	*32.22*	*33.79*
Nitrogen free extract, % DM	*42.29*	*40.15*
Ash, % DM	*9.72*	*13.25*
Calcium, % DM	*0.32*	*0.23*
Phosphorus, % DM	*0.27*	*0.22*
Gross energy, MJ/ kg DM	*18.02*	*17.33*

Source: Own calculation.

Stybayev et al. [21] stated that the proso millet hay had 947.3 g/kg DM with nutrient content 9.07% CP, 2.76% EE, 30.32% CF, 3.32% sugar, 9.25% ash, 1.11% Ca, 0.23% P, but hay from Sudan grass plant 952.2 g/kg DM, 10.17%

CP, 2.75% EE, 30.49% CF, 8.83% sugar, 4.51% ash, 0.97% Ca, 0.23% P, respectively.

The conservation of fodder crops is a traditional way of reducing seasonal variations in feed availability for farm animals. The silage is an important source of nutrients for the dairy production sector in the autumn - middle spring period.

Silage plays an important role in the nutrition, wellbeing and productivity of animals. It can help solving some problems in the animal husbandry sector by providing a balanced diet for livestock with an appropriate amount of protein and fiber. When opening the glass containers with proso millet silage, there was no gas or juice leakage from the preserved mass. As for the organoleptic properties, the silage prepared from *Panicum miliaceum* had yellowish-green stems and leaves with pleasant smell of pickled apple; the texture of the plants stored as silage was preserved well, without mold and mucus. It has been determined that pH =4.0, most organic acids were in fixed form, butyric acid not was detected and lactic acids constituted 86% of organic acids. The nutrient content of the prepared silages is shown in Table 3.

Table 3. The biochemical composition and the fodder value of the silage from the studied *Poaceae* species

Indices	*Panicum miliaceum*	*Festuca arundinacea*	*Zea mays*
pH index	4.00	4.38	*3.92*
Crude protein, % DM	11.07	6.65	*7.28*
Crude fats, % DM	4.01	2.44	*3.94*
Crude cellulose, % DM	36.65	36.87	*19.02*
Nitrogen free extract, % DM	38.61	41.53	*66.22*
Soluble sugars, % DM	1.03	0.46	*0.91*
Starch, % DM	0.62	0.58	*24.54*
Ash, % DM	9.66	12.51	*3.55*
Calcium, % DM	0.31	0.24	*0.27*
Phosphorus, %	0.27	0.18	*0.27*
Gross energy, MJ/ kg	18.38	17.23	*18.72*

Source: Own calculation.

It was found that during the process of ensiling, the concentrations of crude protein, soluble sugars and starch decreased. In comparison with the initial mass, in the prepared silage from *Panicum miliaceum* the level of crude fats and crude cellulose increased substantially, but nitrogen free extract, soluble sugars and starch – decreased, crude protein and ash did not change essentially. The dry matter of proso millet silage contained a high amount of crude protein, crude cellulose and ash, but very low amount of nitrogen free extract, soluble sugars and starch, as compared with the corn silage. The ensiled fodder from *Panicum miliaceum* was characterized by optimal gross energy concentrations, but lower than corn silage. The silage from tall fescue had low concentration of crude protein and gross energy.

Some authors mentioned various findings about the quality of the silage prepared from *Panicum* species. Paziani et al. [19] reported that the fodder value of *Panicum maximum* silages had the following indices: pH =4.7-4.9, 8.5-11.0% CP, 38.7-46.4% ADF, 49.8.8-69.4% NDF, 8.3-11.2 % ash. Piłat et al. [20] found that the quality of *Panicum virgatum* silage was characterized by 204.4 g/kg DM, pH =4.57, 1.19% lactic acid, 0.71% acetic acid, 0.08% butyric acid, 91.61% OM, 11.84 % CP, 33.91% CF, 42.87% NFE, 74.57% NDF, 43.22% ADF, but the silage with chemical supplements and microbial additive – 238.8-254.4 g/kg DM, pH =4.31-4.60, 1.25-1.26% lactic acid, 0.65-0.671% acetic acid, 0-0.06% butyric acid, 91.49-92.14% OM, 11.43-12.64 % CP, 33.62-35.76% CF, 40.22-41.29% NFE, 70.30-71.72% NDF, 39.24-41.01 % ADF. Wei et al. [27] reported that ensiled mass from proso millet had 266.8 g/kg DM with nutrient content 5.96% CP, 33.00 % ADF, 58.60 % NDF but corn ensiled mass 264.1 g/kg DM, 5.30% CP, 24.15 % ADF, 44.55 % NDF and ensiled mass from sorghum-Sudan grass plants 178.4 g/kg DM, 4.61% CP, 41.32 % ADF, 63.50 % NDF, respectively. Maksimova et al. [15] stated that silage from *Panicum miliaceum* cv. *Baganskoye 88* had pH =5.0, 0.55 feed units/kg DM, 39.0 g/kg DM digestible protein, 8.21 MJ/ kg DM exchange energy, 17.3-17.6 MJ/ kg DM gross energy and 72.5 g digestible proteins/ feeding unit. In our previous research [25] found that dry matter nutrient content of ensiled fodder from common millet plants was 13.3% CP, 11.5% ash, 37.0% CF, 37.1% ADF, 63.0% NDF, 2.0% ADL, 6.8% TSS, 35.1% Cel, 23.7% HC

with fodder and energy value 600 g/kg DDM, RFV=92, 11.87 MJ/kg DE, 9.75 MJ/kg ME, 5.76 MJ/kg NEl.

On the basis of our observations, *Panicum miliaceum 'Marius'*, under the soil climatic conditions of the Republic of Moldova, reached seed maturity in end August, 28 days earlier than corn hybrid *'Porumbeni 374'*. The *Panicum miliaceum* '*Marius*' grain dry matter contained 140.0 g/kg CP, 47.5 g/kg EE, 137.0 g/kg CF, 627.4 g/kg NFE, 48.0 g/kg ash, 0.9 g/kg Ca and 0.6g/kg P, 10.7 g/kg soluble sugars, 313.7 g/kg starch. Medvedev & Smetannikova [16] revealed that the *Panicum miliaceum* grain contained 10.4-15.5% CP, 2.5-3.3% minerals, 7.8-10.5% CF, 2.6-4.2% EE, 57.8-63.9% NFE, 0.93-1.1 feed units/kg DM.

Increasing biomass usage leads to the reduction of greenhouse gas emissions, as compared with the use of fossil fuels. In recent years, the considerations for the use of *Poaceae* species for bioenergy have increased considerably, it can be used as biomass feedstock for the production solid fuel, lignocellulosic bioethanol, synthetic natural gas or synthetic biofuels, and in particular for biogas production. The C_4 grasses are considered as a potential feedstock for biogas production, due to their low water consumption as compared with other crops, and the fact that they can be cultivated in non-arable lands, avoiding the direct competition with food crops. Biogas is a product of anaerobic fermentation of organic products. Among the fuels from plant biomass, biogas has a great importance and can successfully replace fossil fuels to obtain electric power and heat. The quantities of biogas and the methane content depend mainly on carbohydrates, fats and proteins, the biodegradability and ratio of carbon and nitrogen (C/N) from the substrates. The results of the determination of the quality of substrates of green mass and prepared silages are presented in Table 4.

Table 4. Biochemical methane production potential of green and ensiled mass substrates from leguminous species

Indices	***Panicum miliaceum***		***Festuca arundinacea***		***Sorghum bicolor x Sorghum sudanense*** green mass	***Zea mays***	
	green mass	silage	green mass	Silage		green mass	silage
Organic dry matter, g/kg	*919.0*	*903.4*	*869.1*	*874.9*	*894.4*	*964.1*	*964.5*
Digestible matter, g/kg	*662.3*	*646.7*	*560.5*	*556.6*	*640.5*	*678.0*	*686.9*
Digestible proteins, g/kg	*80.7*	*84.0*	*69.2*	*42.1*	*59.2*	*42.1*	*42.2*
Digestible fats, g/kg	*17.4*	*24.9*	*14.2*	*12.9*	*12.3*	*19.2*	*26.8*
Digestible carbohydrates, g/kg	*564.2*	*537.8*	*477.1*	*501.6*	*569.0*	*616.7*	*617.9*
Carbon, g/kg	*510.6*	*501.9*	*428.8*	*486.1*	*496.9*	*535.6*	*535.8*
Nitrogen, g/kg	*17.0*	*17.7*	*17.3*	*10.6*	*13.6*	*11.6*	*11.7*
Ratio carbon/nitrogen	*30.0*	*28.4*	*24.8*	*45.9*	*36.5*	*46.2*	*45.8*
Biochemical methane potential, L/kg DM	*278*	*275*	*235*	*230*	*265*	*281*	*288*
Biochemical methane potential, L/kg OM	*303*	*305*	*270*	*263*	*296*	*291*	*299*

Source: Own calculation.

It is a commonly known fact that methanogenic bacteria need a suitable ratio of carbon to nitrogen for their metabolic processes, ratios higher than 30:1 were found to be unsuitable for optimal digestion, and ratios lower than 10:1 were found to be inhibitory, because of low pH, poor buffering capacity and high concentrations of ammonia in the substrate. The C/N ratio is more favorable in proso millet substrates as compared with the other substrates. The digestible organic matter concentration in the tested substrates ranged from 556.6 to 686.9 g/kg, the methane potential of the digestible organic matter varied from 230 to 288 l/kg dry matter or specific methane yield – from 263 to 305 l/kg organic matter. The lowest results were achieved in tall fescue substrates, with rather low concentration of digestible matter. The biochemical methane potential of studied millet substrates ranged from 303 to 305 l/kg organic matter, being about the same as in corn and sorghum x Sudan grass substrates.

According to Battista et al. [5], the methane yield of *Panicum miliaceum* substrate was 253 L/kg, *Zea mays* substrate – 289 ± 86 L/kg, *Triticum aestivum* substrate – 351 ± 5 L/kg, *Hordeum distichon* substrate – 290 ± 83 and *Sorghum* spp. substrate – 313 ± 73 L/kg.

Baute et al. [6] reported that the methane potential of *Panicum virgatum* harvested in July reached 186.5 L/kg VS, but – harvested in October – 160.1 L/kg VS, respectively. Holder et al. [11] found that the biochemical methane potential of the substrate from guinea grass, *Panicum maximum*, was 250 l/kg DM. Kupryś-Caruk et al. [14] remarked that *Panicum virgatum* control silages had methane yields 310 l/kg ODM, while the inoculated silage had a yield of 380 l/kg ODM.

CONCLUSIONS

The forage value of *Panicum miliaceum 'Marius'* whole plants is 10.62% CP, 2.81% EE, 30.96% CF, 47.60% NFE, 8.01 % ash, 0.30% Ca, 0.23% P, with 18.21 MJ/kg GE, 9.29 MJ/kg ME, 5.23 MJ/kg NEl.

The ensiled mass is characterized by pleasant smell and color, the dry matter nutrient and feed energy values are: 11.07% CP, 4.01% EE, 36.65% CF, 38.61% NFE, 9.66 % ash, with 18.38 MJ/kg GE, 8.61 MJ/kg ME, 4.69 MJ/kg NEl.

The common millet hay contained 13.40% CP, 2.37% EE, 32.22% CF, 42.29% NFE, 9.72 % ash with nutritive energy value 18.02 MJ/kg GE, 8.66 MJ/kg ME and 4.84 MJ/kg NEl.

The *Panicum miliaceum 'Marius'* substrates used for renewable energy production by anaerobic digestion had optimal carbon to nitrogen ratio and the estimated biochemical methane potential reached 303-305 l/kg organic matter.

The *Panicum miliaceum 'Marius'* grain contained 140.0g/kg CP, 47.5 g/kg EE, 137.0 g/kg CF, 627.4 g/kg NFE, 48.0 g/kg ash, 0.9 g/kg Ca and 0.6g/kg P.

The cultivar 'Marius' of Proso millet is characterized by optimal productivity, can be used in monoculture or as a component of the mix of annual legume crops, and the harvested green mass may be used as forage for livestock as natural fodder, hay, haylage, and also as substrate in biogas reactors via anaerobic digestion for renewable energy production.

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