EVALUATION OF THE QUALITY OF GREEN MASS AND HAY FROM *Bromus inermis* Leyss AND *Bromus tectorum* L. AND THEIR POTENTIAL APPLICATION IN MOLDOVA

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Abstract. The goal of this study was to evaluate the quality indices of green mass and hay from local ecotypes of *Bromus inermis* and *Bromus tectorum*, grow in an experimental field at the "Alexandru Ciubotaru" National Botanical Garden (Institute) of Moldova State University. The quality indices of the harvested green mass varied between species as follows: 9.4-12.4% crude protein (CP), 33.6-37.7% crude fiber (CF), 62.9–64.7% neutral detergent fiber (NDF), 36.9-38.8% acid detergent fiber (ADF), 3.6-4.7% acid detergent lignin (ADL), 33.0-34.1% cellulose (Cel), 26.0–27.8% hemicellulose (HC), 13.5-17.9% total soluble sugars (TSS), and 9.4-10.5% ash. The nutritive and energy values of green mass fodder: 587–602 g/kg dry matter digestibility (DMD), relative feed value (RFV) of 84-90, metabolizable energy (ME) of 9.56-9.76 MJ/kg, and net energy for lactation (NEl) of 5.57-5.79 MJ/kg.The nutrient content and energy value of the hays prepared from *Bromus* species were characterized by the following indices: 9.2-10.3% CP, 10.8-11.4% ash, 36.0-39.9% CF, 38.4-40.7% ADF, 65.0-65.7% NDF, 4.6-5.7 % ADL, 6.2-9.4% TSS, 574-590g/kg DDM, RFV=81-84, 11.41-11.70 MJ/kg DE, 9.37-9.60 MJ/kg ME and 5.39-5.62 MJ/kg NEl. The biochemical methane potential of the *Bromus* substrates ranged from 298 to 351 L/kg VS. These results indicate that the local ecotypes of *Bromus inermis* and *Bromus tectorum* possess optimal nutrient profiles, making them suitable as forages for livestock and as promising substrates for biomethane production as a renewable energy source.

Keywords: biochemical methane potential, *Bromus inermis*, *Bromus tectorum*, nutrient composition, green mass and hay, feed value.

Rezumat. Evaluarea calității masei verzi recoltate și a fânului de *Bromus inermis* Leyss și *Bromus tectorum* L. și potențialul aplicativ de valorificare a acestora în Moldova. Scopul prezentului studiu a constatat în evaluarea indiciilor de calitate a masei verzi recoltate și a fânului preparat din ecotipurile locale a speciilor de *Bromus inermis* și *Bromus tectorum*, crescute pe terenul experimental din Grădina Botanică Națională (Institut) "Alexandru Ciubotaru" a Universității de Stat din Moldova. S-a constatat că indicii de calitate ai masei verzi recoltate variază în dependență de specie: 9.4-12.4% proteină brută (CP), 33.6-37.7% celuloză brută (CF), 62.9-64.7% fibre solubile în detergent neutru (NDF), 36.9-38.8% fibre solubile în detergent acid (ADF), 3.6-4.7% lignină sulfurică (ADL), 33.0-34.1% celuloză (Cel), 26.0-27.8% hemiceluloză (HC), 13.5-17.9% total zaharuri solubile (TSS), 9.4-10.5% cenușă. Valoarea nutritivă și energetică a furajului din masa verde a acestor plante e caracterizată de următorii indici: 587-602 g/kg substanță uscată digestibilă (DDM), valoarea relativă a furajului (RFV) = 84-90, 9.56-9.76 MJ/kg energie metabolizantă (ME) și 5.57-5.79MJ/kg energie netă pentru lactație (NEl). Conținutul de nutrienți și valoarea energetică a fânurilor preparate din speciile studiate de *Bromus*: 9.2-10.3% CP, 10.8-11.4% cenușă, 36.0-39.9% CF, 38.4-40.7% ADF, 65.0-65.7% NDF, 4.6-5.7 % ADL, 6.2-9.4% TSS, 574-590 g/kg DDM, RFV=81-84, 11.41-11.70 MJ/kg DE, 9.37-9.60 MJ/kg ME și 5.39-5.62 MJ/kg NEl. Potențialul biochimic de obținere a metanului în substraturile cercetate de *Bromus* variază de la 298 la 351 l/kg materie organică. Ecotipurile locale de *Bromus inermis* and *Bromus tectorum* au un conținut optimal de nutrienți și pot fi valorificate ca furaj pentru animale de fermă, precum și ca substrat pentru obținerea biometanului ca energie renovabilă.

Cuvinte cheie: potențial biochimic de obținere a biometanului, *Bromus inermis, Bromus tectorum,* conținutul de nutrienți, masă verde și fân, valoarea nutritivă a furajelor.

INTRODUCTION

The genus *Bromus* L. (family Poaceae) comprises approximately 100-170 accepted annual and perennial species distributed worldwide, with a large number of species found in the temperate regions (VOGEL et al., 1996; ROJAS-SANDOVAL, 2024). Of these, about 10 species are cultivated for agricultural purposes, while the rest are generally considered weeds. Floristic research has identified 11 species of the *Bromus* genus present in the territory of the Republic of Moldova (PÎNZARU, 2023).

Bromus inermis Leyss (syn. *Bromopsis inermis* (Leyss.) Holub, *Festuca inermis* (Leyss.) DC., *Forasaccus inermis* (Leyss.) Lunell, *Schedonorus inermis* (Leyss.) P. Beauv., *Zerna inermis* (Leyss.) Lindm.), commonly known as smooth brome, is a creeping rhizomatous perennial C3 grass, native to Europe and parts of Asia. It is a widespread species and has been introduced to various regions, including North America. Stems are erect, glabrous or retrorsely hairy below the nodes, and can reach up to 150 cm in height. Leaves are greyish-blue on the upper surface and green on the lower side. Leaf sheaths are glabrous or shortly hairy; leaf blades are flat, 15–40 cm long and 5–10 mm wide, with both surfaces and margins scabrid, glabrous, or sparsely ciliate at the margins. Leaf tips are acuminate, and the ligule measures 1–2 mm. The inflorescence is an open panicle, 5–20 cm long, with 1 to 4 branches per node. Spikelets are purple-brown, typically 15–30 mm long, with 6–12 florets. Rachilla internodes measure 2–3 mm and are spinulose. Glumes are lanceolate with membranous margins; the lower glume is 4–7 mm long and 1-veined, while the upper glume is 6–10 mm long and 3-veined. Lemmas are oblong-lanceolate, 8–12 mm long, 5–7-veined, glabrous, scabrid at the base, and have obtuse or emarginate apices. They may be awned (up to 3–4 mm) or awnless. Paleas are shorter than the lemmas, with ciliate keels. Anthers are 3–4 mm long. *Bromus inermis* is an open-pollinated, self-incompatible species. Flowering occurs from late May to early July. Caryopses are elliptical, 5–8 mm long, and vary in color from pale yellow to dark brown. The weight of 1000 seeds range from 2 to 3 g. Chromosome numbers include 2n = 14, 28, or 56. Seeds remain viable for 6–10 years. This species commonly occurs along roadsides, riverbanks, field edges, prairies, woods, and pastures. It reproduces via seeds, tillers, and rhizomes. It prefers well-drained soils with a pH of 5.5–8.0 but can tolerate acidic and poorly drained conditions. It thrives in regions with annual precipitation exceeding 380 mm. Its notable drought tolerance is attributed to its deeply penetrating root system and vigorous rhizome growth. Smooth bromegrass has excellent seedling vigor and establishes readily when sown in early spring. In subsequent years, growth begins in early spring and continues into late fall. It is one of the most important grasses used in pastures and hayfields, as well as for soil erosion control and land reclamation. It is often seeded in combination with perennial legume species, which typically enhances both yield and forage quality. Contemporary cultivars of smooth bromegrass are highly productive over 13-20 t/ha of dry matter. At present, smooth brome is researched and cultivated in many countries on several continents (OTFINOWSKI et al., 2007; ALBAYRAK et al., 2011; ÜNAL & MUTLU, 2015; KAZARINA et al., 2019; SOKOLOVIĆ et al., 2019; KARBIVSKA et al., 2020; TAN & ÇORUH, 2021; BAYKALOVA & SEREBRENNIKOV, 2022; FEOKTISTOVA & LEONIDOV, 2022; BOZHANSKA et al., 2022; YANG et al., 2023; MACKIEWICZ-WALEC et al., 2024; ROJAS-SANDOVAL, 2024; WALISZEWSKA et al., 2024).

Bromus tectorum L. (syn. *Anisantha tectorum* (L.) Nevski) known as downy brome, drooping brome, cheatgrass native to Europe, southwestern Asia, and northern Africa. Is a tufted, annual grass that typically forms dense clumps. The stems are smooth, slender, and erect up to 30-80 cm in height. The leaves are linear, slender, and can be up to 10-35 cm long and 2-4 mm wide, covered with fine hairs, giving them a somewhat soft texture. *Bromus tectorum* plants have robust multilateral panicles of florets, 6-20 cm in length, lax, pendulous at the end, with simple and rough branches. The spikelets are sub-cylindrical to slightly compressed. The flowers themselves are small, 3-7 mm long, the lemma linear-subulate, 12-20 mm long with 5-7 veins and the tip has two teeth 2-3 mm long, arista 15-30 mm long and ligule of about 4 mm, with 3 stamens. The flowers can vary in color, often appearing green to purplish as they mature. Flowering occurs from May to June. The caryopsis is about 13-18 mm long with a recurved, sharp-tipped awn. The color of the caryopsis ranges from light straw to reddish brown, and is covered with silicon barbs that aid in attachment to wool, hair and clothing. Under optimal conditions seed productivity 330-450 kg per hectare. *Bromus tectorum* has a fibrous root system with few main roots that does not reach more than 35 cm into the soil, and has wide-spreading lateral roots that make it efficient at absorbing moisture from light precipitation episodes. This grass thrives in a variety of soil types, with a preference for well-drained soils. It is typically found in areas with full sun and can tolerate drought conditions, making it well-suited to arid and semi-arid environments. It commonly occurs in habitats ranging from steppe zones to coastal vegetation belts, particularly in dry, ruderal, and sandy areas. As a pioneer species, it plays a role in providing ground cover and stabilizing soil; in some regions, it is also used as forage for livestock, although its nutritional value can vary (KLEMMEDSON & SMITH, 1964; UPADHAYA et al., 1986; KHAN et al., 2013).

The goal of this study was to evaluate the quality indices of green mass and hay from *Bromus inermis* and *Bromus tectorum* and their potential application as fodders for farm animals and as substrates for the biomethane production, under the conditions of the Republic of Moldova.

MATERIALS AND METHODS

The study focused on local ecotypes of *Bromus inermis* and *Bromus tectorum* cultivated in an experimental plot at the "Alexandru Ciubotaru" National Botanical Garden (Institute) of Moldova State University, Chișinău. Samples of *Bromus tectorum* were collected during the pre-flowering stage, while samples of *Bromus inermis* were harvested at the first cut, also during the pre-flowering stage, in the second year of growth. The hay was dried in the field. The dry matter content was determined by drying the samples at 105°C until a constant weight was achieved. Both green mass and hay samples were further dehydrated in an oven with forced air circulation at 60°C. After drying, the plant material was finely ground using a laboratory ball mill. The quality of the green mass and hay was assessed based on several parameters: crude protein (CP), crude fiber (CF), ash, acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL), and total soluble sugars (TSS). These were measured using near-infrared spectroscopy (NIRS) with the PERTEN DA 7200 analyzer at the Research and Development Institute for Grasslands in Brașov, Romania. Hemicellulose (HC) and cellulose (Cel) contents, along with digestible dry matter (DDM), relative feed value (RFV), digestible energy (DE), metabolizable energy (ME), and net energy for lactation (NEl), were calculated using standard methodologies. The carbon content of the biomass was estimated using an empirical formula from BADGER et al., (1979), and the biochemical methane potential (BMP) was determined based on the equations provided by DANDIKAS et al., (2015).

RESULTS AND DISCUSSIONS

The analysis of the agrobiological characteristics revealed certain differences in the growth and development patterns of the studied *Bromus* species. *Bromus tectorum* exhibited a more rapid growth rate, with panicle emergence occurring 7-12 days earlier than in *Bromus inermis*. At the time of harvest, *Bromus tectorum* plants reached a height of 38-43 cm, whereas *Bromus inermis* attained 99-109 cm. The green mass yield of the *Bromus tectorum* ecotype was 1.76 kg/m², with a dry matter content of 23.20%. In contrast, the local ecotype of *Bromus inermis* produced 4.19 kg/m² of green mass with a dry matter content of 26.97%.

The dry matter content and nutrient concentration of whole harvested plants are key indicators of forage nutritive value. The quality parameters of the green mass from the studied *Bromus* species are summarized in Table 1. The forage from *Bromus inermis* was characterized by a significantly higher crude protein content and lower levels of crude fiber, neutral detergent fiber and acid detergent lignin as compared to *Bromus tectorum*. In contrast, *Bromus tectorum* forage exhibited higher concentrations of total soluble sugars and hemicellulose. Additionally, *Bromus inermis* forage demonstrated superior values in terms of dry matter digestibility, metabolizable energy and net energy for lactation, indicating its higher nutritional quality relative to *Bromus tectorum*.

Table 1. The nutrient composition and the feed value of the green mass from the studied *Bromus* species.

Indices	***Bromus inermis***	***Bromus tectorum***
Crude protein, g/kg DM	124	94
Crude fiber, g/kg DM	336	377
Ash, g/kg DM	94	105
Acid detergent fiber, g/kg DM	369	388
Neutral detergent fiber, g/kg DM	629	647
Acid detergent lignin, g/kg DM	36	47
Total soluble sugars, g/kg DM	135	179
Cellulose, g/kg DM	330	341
Hemicellulose, g/kg DM	260	278
Dry matter digestibility, %	60.2	58.7
Digestible energy, MJ/kg DM	11.89	11.64
Metabolizable energy, MJ/kg DM	9.76	9.56
Net energy for lactation, MJ/kg DM	5.79	5.57
Relative feed value	90	84

Several authors have reported findings on the quality of green mass in various *Bromus* species. According to MEDVEDEV & SMETANNIKOVA (1981), the green mass of *Bromus inermis* contained 60-81% moisture, 2.9-4.4% CP, 5.9-10.5% CF, 0.4% EE, 1.5-2.6% ash, and 7.6-18.3% nitrogen-free extract (NFE), while for *Bromus variegatus*, the values were 64-74% moisture, 2.0-4.7% CP, 9.6-12.4% CF, 0.7-0.9% EE, 2.2% ash, and 11.2-16.2% NFE. UPADHAYA et al., (1986) examined the chemical composition and energy value of *Bromus tectorum* at two growth stages. At the boot stage, the plant contained 15.4% crude protein, 2.7% crude fat, 27.4% cellulose, 4.1% lignin, 40.2% other carbohydrates, 10.2% ash, 0.64% calcium, 0.36% phosphorus, and 4320 kcal/kg energy. At the head stage, the crude protein level decreased to 11.1%, crude fat to 2.1%, while cellulose increased to 30.6%, lignin to 4.4%, and other carbohydrates to 41.5%; ash was 10.3%, calcium 0.60%, phosphorus 0.32%, with slightly higher energy level– at 4341 kcal/kg. MAY et al., (1998) mentioned the nutrient values determined in the dry matter of several *Bromus* species. Thus, for *Bromus inermis*, the forage contained 9.9-11.3% CP, 62.9-69.5% NDF, 42.1-43.3% ADF, 4.9-5.5% ADL, 6.3-7.6% ash, and 56.9-70.6% IVDMD; *Bromus riparius* had similar values: 9.7-11.3% CP, 65.3-66.8% NDF, 40.1% ADF, 4.3-4.7% ADL, 6.3-7.6% ash, and 60.7-71.4% IVDMD; *Bromus carinatus* was found to contain 11.5-11.6% CP, 63.1-65.4% NDF, 38.0-40.6% ADF, 3.5-4.1% ADL, 7.0-7.5% ash, and 56.9-70.6% IVDMD; *Bromus ciliatus* showed 12.0-13.7% CP, 63.1-64.7% NDF, 34.3-37.9% ADF, 2.7-3.1% ADL, 6.4-7.5% ash, and 66.6-76.1% IVDMD; *Bromus anomalus* contained 12.9-13.5% crude protein, 69.0-69.95% NDF, 40.3-42.1% ADF, 2.9-3.6% ADL, 7.0-7.1% ash, and 64.7-74.9% IVDMD. ARZANI et al., (2004) studied the nutritive components of different plant parts of *Bromus tomentellus* and reported that the leaf dry matter contained 14.1% crude protein, 52.8% NDF, 30.4% ADF, 64.4% DMD, and 9.0 MJ/kg of metabolizable energy (ME), while the stems contained 7.0% crude protein, 70.3% NDF, 48.8% ADF, 46.6% DMD, and 5.96 MJ/kg ME, but the flowers contained 10.4% crude protein, 60.7% NDF, 38.3% ADF, 56.4% DMD, and 7.6 MJ/kg ME. UTYAMISHEV & REZNICENKO (2009) evaluated the chemical composition and feed value of *Bromus inermis* at different growth stages, during the earing stage, plants contained 15.16% CP, 2.49% EE, 28.88% CF, 46.27% NFE, 1.12% starch, 1.95% sugars, 7.2% ash, 18.50 MJ/kg GE, and 9.43 MJ/kg ME; at the flowering stage, values shifted to 7.42% CP, 1.67% EE, 30.63% CF, 54.57% NFE, 4.80% starch, 4.01% sugars, 5.33% ash, 552 g/kg DMD, 18.14 MJ/kg GE, and 9.11 MJ/kg ME; In the early seed formation stage, the composition was 7.89% CP, 1.67% EE, 34.81% CF, 48.89% NFE, 3.93% starch, 3.71% sugars, 6.60% ash, 18.11 MJ/kg GE and 8.92 MJ/kg ME. HAYES et al., (2010) mentioned that *Bromus stamineus* herbage contained 7.0 %CP, 61.3 % NDF, 33.3 % ADF, 7.0% ash, 58.7 % DMD and 8.5 MJ/kg ME. ALBAYRAK et al., (2011) compared the forage quality of brome grass and crested wheatgrass. Brome grass exhibited 10.45-11.30% CP, 57.85-59.70% NDF, 41.75-43.50% ADF, 45.16-47.45% total digestible nutrients (TDN), and -RFV of 85.57-88.11. Crested wheatgrass, in contrast, had 8.90-9.50% CP, 59.64-61.81% NDF, 45.79-48.67% ADF, 42.29-44.28% TDN, and RFV ranging from 80.16 to 83.53. AMIRI et al., (2012) mentioned that the quality indices of *Bromus tomentellus* fodder were 298.8 dry matter, 2.40% EE, 12.40% % ash, 14.81% CP, 30.50% ADF, 61.13% NDF, 65.62% DMD, 9.16 MJ/kg ME and RFQ =99.86. NAYDENOVA (2012) mentioned that the green mass of *Bromus inermis* harvested in the heading period contained 16.55-20.29 % CP, 27.83-30.04 % CF, 33.45-41.62 % ADF, 59.44-64.12 % NDF, 2.71-5.85% ADL, 22.50-26.00% HC, 30.74-35.77% Cel, 58.04-70.38 % IVDMD, 54.17-68.65 % IVOMD, 10.45-11.04 MJ/kg ME and RFV=132-172, while the forage cut in the flowering period – 14.11-15.23 % CP, 30.99-33.97 % CF, 42.50-43.54 % ADF, 66.00-67.37 %

NDF, 6.29-7.06% ADL, 23.50-23.83% HC, 36.21-36.48% Cel, 44.44-49.68 % IVDMD, 41.66-47.30 % IVOMD, 7.96-8.72 MJ/kg ME and RFV=122-126. ALBAYRAK & TÜRK (2013) found that the smooth bromegrass plants harvested in late May contained 8.5-8.7% CP, 61.1-61.3% NDF, 44.6-46.4% ADF, RFV=80-82, orchardgrass plants 9.2-9.5% CP, 56.5-57.8% NDF, 42.5-43.7% ADF, RFV=88-92, and meadow fescue plants – 8.1-8.9% CP, 58.2-59.2% NDF, 41.5-44.8% ADF, RFV=86-89, respectively. KHAN et al., (2013) reported that the dry matter from *Bromus tectorum* whole plants had 8.50% CP, 68.19% NDF, 42.71% ADF, 12.49 % ash, 0.29% calcium. BILIGETU et al., (2014) reported that whole plants of *Bromus riparius* contained 5.0% CP, 59.6% NDF, 36.9% ADF, 0.88% calcium, 0.1% phosphorus, and 50.0% IVOMD. SHADNOUSH (2014) found that *Bromus tomentellus* harvested at the blooming stage had 6.8% CP, 35.0% CF, 74.2% NDF, 41.2% ADF, 45.3% DMD, and 51.9% OMD. In comparison, *Agropyron intermedium* had 8.0% CP, 32.6% CF, 68.1% NDF, 40.5% ADF, 50.2% DMD, and 59.3% OMD. ÜNAL & MUTLU (2015) reported that smooth bromegrass cut at the blooming stage had quality indices ranging between the following indices 17.82-21.78% CP, 62.00-66.38% NDF, 34.55-37.67% ADF, and RFV of 107.72–113.89. GÜRSOY & MACİT (2017) stated that *Bromus variegatus* forage contained 5.35% ash, 13.03% CP, 2.78% EE, 56.46% NDF, 29.89% ADF, 4.66% ADL, 65.62% DMD, and an RFV of 108.16. JENSON et al., (2017) observed that smooth brome cut in June had 13.4% CP and 48.1% NDF, with a neutral detergent fiber digestibility of 73.7%. For meadow brome, the values were 11.5% CP, 54.1% NDF, and 67.9% neutral detergent fiber digestibility. CHORNOLATA et al., (2023) found that during the heading period, *Bromus inermis* had 6.15-8.92% CP, while *Bromus riparius* had 6.55-8.81% CP. TENIKECIER & ATES (2018) remarked that *Bromus inermis* harvested in full bloom stage had 14.23 % CP, 55.11 % NDF, 30.19 % ADF, 3.88 % calcium and 0.22 % phosphorus. TÜRK et al., (2018) reported that the forage from *Bromus inermis* contained 8.91% CP, 59.55 % NDF, 45.11 % ADF, 43.11% TDN, RFV=83.96, but in variants with different nitrogen doses 8.88-12.02% crude protein, 51.49-58.01 % NDF, 36.38-43.34 % ADF, 45.40-54.38% TDN, RFV=88.40-109.38. BANDANOVA & BUTUKHANOV (2019), in evaluating awnless brome forage quality, found that plants harvested at the earing stage contained 16.3% CP, 2.9% EE, 34.0% CF, 36.8% NFE, 5.3% ash, 1.32% calcium, and 0.37% phosphorus. At the flowering stage, the values were 14.8% CP, 3.0% EE, 37.8% CF, 37.0% NFE, 7.53% ash, 1.40% calcium, and 0.30% phosphorus. KAZARINA et al., (2019) reported that local varieties of *Bromus inermis* had 13.56–16.39% protein, 8.26–13.37% sugars, and 102.6–174 mg/kg carotene. PAVLOVA et al., (2019) stated that the chemical composition and nutritive value of *Bromus inermis* monoculture green mass included 10.6% CP, 1.7% EE, 35.0% CF, 47.5% NFE, 8.5 MJ/kg ME, 0.58 nutritive units/kg, and 63.7 g digestible protein per nutritive unit. SOKOLOVIĆ et al., (2019) revealed that the nutrient composition of *Bromus inermis* 'Kruševački 46' at first cut was 11.61% CP, 33.23% CF, 3.09% EE, 60.19% NDF, 40.33% ADF, and 7.69% ash. At second cut, it had 13.51% CP, 30.57% CF, 5.39% EE, 57.26% NDF, 36.34% ADF, and 11.51% ash. KARBIVSKA et al., (2020) reported that in *Bromus inermis* without fertilizer, forage contained 10.6% CP, 3.3% EE, 29.9% CF, 49.9% NFE, 8.3% ash, 0.41% calcium, 0.34% phosphorus, 55% DDM, 0.69 fodder units/kg, 8.0 MJ/kg ME, and 109 g digestible protein per nutritive unit. When applying fertilizers, the values ranged from 10.7-14.8% CP, 3.4% EE, 29.8-30.2% CF, 43.2-44.7% NFE, 8.4% ash, 0.41-0.44% calcium, 0.33-0.34% phosphorus, 55-56% DMD, 0.70-0.71 fodder units/kg, 8.1-8.2 MJ/kg ME, and 107-147 g digestible protein/fodder unit. SHEPELEV et al., (2020) mentioned that concentration of nutrients in green mass from *Bromus inermis* varieties developed at the Omsk Agricultural Scientific Center, varied from 13.39 to 17.07% CP and 29.9-33.0% CF. GOMEZ-MIRANDA et al., (2021) observed that *Bromus catharticus* herbage in spring contained 155.5 g/kg dry matter (DM), 19.6% CP, 55.90% NDF, 26.57% ADF, 11.54% ash, 67.84% IVOMD, and 10.9 MJ/kg ME. In autumn, the herbage contained 175.6 g/kg DM, 23.61% CP, 53.31% NDF, 22.21% ADF, 15.39% ash, 78.73% IVOMD, and 11.8 MJ/kg ME. GÜRSOY et al., (2021) reported that variegated brome contained 8.63% ash, 1.81 EE, 15.75% CP, 21.62% CF, 56.46% NDF, 27.29% ADF, 7.74% ADL, 7.85 MJ/kg ME, 4.54 MJ/kg NEL, 73.43% TDN, 70.03% TDMD, 58.82% TNDFD, 97.45 TOMD and RFQ=149.79. BAYKALOVA & SEREBRENNIKOV (2022) found that the studied cultivars of *Bromus inermis*, when cut at the budding stage, contained 17.5-25.5% CP, 24.13-28.4% CF, and 1.7-1.9 MJ/kg ME in fresh mass. FEOKTISTOVA & LEONIDOV (2022) noted that the new cultivar of *Bromus inermis* 'Gvardeets' is characterized by a foliage content of 38-50% in the harvested mass. Its protein content in dry matter ranged from 7.0-12.0%, and the fiber content was in the range 28.2-34.0%. BOZHANSKA et al., (2022) remarked that *Bromus inermis* plants contained 13.26-15.27% CP, 2.17-2.31% EE, 34.30-41.23% CF, 35.51-41.78% NFE, 5.67-6.71 % ash, 0.9-2.78% Ca, 0.06-0.21% P, while *Festuca arundinacea* plants 9.89-15.26% CP, 1.49-2.40% EE, 32.06-37.27% CF, 39.55-48.38% NFE, 6.39-7.26 % ash, 0.8-2.31% Ca, 0.03-0.17% P. ACATRINEI (DUMITRU) et al., (2023) mentioned that the cultivars of *Bromus inermis* created at the Research-Development Station for Meadows Vaslui, Romania, have a productivity of 10-20.3 t/ha with 12.74-14.66 % crude protein content. WALISZEWSKA et al., (2024) reported that the dry matter from *Bromus inermis* contained 38.65 % cellulose, 14.89 % lignin, 68.40 % holocellulose, 29.75 % hemicellulose and 8.57 % ash; and the dry matter from *Bromus hordeaceus* - 36.39 % cellulose, 12.44 % lignin, 72.93 % holocellulose, 36.54 % hemicellulose and 6.93 % ash.

To ensure year-round nutrition for livestock, it is essential to provide feed throughout all seasons. Storing forage for use during periods when plants are not actively growing is a long-established practice. Among preserved forages, hay remains the oldest and most widely used, although its quality is influenced by factors such as the plant species selected, the timing of harvest, weather conditions during drying, the equipment used for harvesting and transportation and storage conditions. The quality characteristics of the hay prepared from the studied *Bromus* species are presented in Table 2. It has been determined that during the haymaking process, the biochemical composition underwent noticeable changes. We would like to mention that the dry matter of the prepared hays from *Bromus* species contained 9.2-10.3% CP, 10.8-11.4% ash, 36.0-39.9% CF, 38.4-40.7% ADF, 65.0-65.7% NDF, 4.6-5.7 % ADL, 6.2-9.4% TSS, with forage value 574-590g/kg DDM, RFV=81-84, 11.41-11.70 MJ/kg DE, 9.37-9.60 MJ/kg ME and 5.39-5.62 MJ/kg NEl. As compared with the harvested green mass, the hay-making process resulted in an increase in crude fiber, acid detergent fiber, neutral detergent fiber, and acid detergent lignin contents, accompanied by a reduction in total soluble sugars. These changes led to a decrease in dry matter digestibility and the overall nutritive energy value of the hay. *Bromus inermis* hay was characterized by optimal crude protein content and a lower cell wall fraction compared to *Bromus tectorum* hay.

Table 2. The biochemical composition and the feed value of the hay from the studied *Bromus* species.

Indices	***Bromus inermis***	***Bromus tectorum***
Crude protein, g/kg DM	103	92
Crude fibre, g/kg DM	360	399
Ash, g/kg DM	108	114
Acid detergent fibre, g/kg DM	384	407
Neutral detergent fibre, g/kg DM	650	657
Acid detergent lignin, g/kg DM	46	57
Total soluble sugars, g/kg DM	62	94
Cellulose, g/kg DM	338	350
Hemicellulose, g/kg DM	266	200
Dry matter digestibility, %	59.0	57.4
Digestible energy, MJ/kg DM	11.70	11.41
Metabolizable energy, MJ/kg DM	9.60	9.37
Net energy for lactation, MJ/kg DM	5.62	5.35
Relative feed value	84	81

Literature sources indicate some variation in the chemical composition and nutritional value of hay from *Bromus* species. MEDVEDEV & SMETANNIKOVA (1981) remarked that hay from *Bromus inermis* had 8.0-12.9% CP, 24.0-29.0 % CF, 2.4-2.9% crude fats, 4.7-8.0% ash and 37.4-41.4% nitrogen free extract. In comparison, *Bromus erectus* hay contained 8.1-10.3% CP, 24.0-27.0 % CF, 1.8-2.1% crude fats, 6.3-6.5% ash and 40.0-45.0% nitrogen free extract. PHILLIPS et al., (2009) reported that *Bromus inermis* hay had 2.10 % N, 71.44 % NDF, and 37.23 % ADF. UTYAMISHEV & REZNICENKO (2009) mentioned that the hay from *Bromus inermis* plants harvested in flowering period had 7.89 % CP, 1.9% EE, 30.0 % CF, 44.9 % NFE and 8.6 MJ/kg ME. ÜNAL & MUTLU (2015) remarked the hay quality from smooth bromegrass cut at the blooming stage was 19.80 % CP, 36.10% ADF, 64.18% NDF, 60.78% DDM, RFV=113.89. JENSON et al., (2017) reported that smooth brome cut in June had 13.4 % CP, 48.1%NDF, 73.7% neutral detergent fiber digestibility (NDFD), but meadow brome 11.5 % CP, 54.1% NDF, 67.9% neutral detergent fiber digestibility (NDFD), respectively. FOSTER et al., (2021) found that the hay from a hybrid bromegrass (*Bromus riparius* × *Bromus inermis*) contained 8.3-8.5 % CP, 38.9-39.6% ADF and 563-571 g/kg TDN. FEHLBERG et al., (2020) mentioned that smooth bromegrass hay had 9.6% CP, 2.7% EE, 63.3 % NDF, 35.6 % ADF, 2.12 Mcal/kg DE for horses. TAN & ÇORUH (2021) remarked the hay quality of smooth bromegrass sowing in spring time was 12.36-13.24 % CP, 35.15-37.54% ADF, 40.16-47.12%NDF, while the hay of smooth bromegrass sown in summer contained 12.38-14.01% CP, 33.94-37.66% ADF, 35.26-47.27% NDF.

Table 3. The biochemical composition and the biomethane production potential of investigated substrates from *Bromus* species.

Indices	***Bromus inermis***		***Bromus tectorum***	
	green mass	hay	green mass	hay
Crude protein, g/kg DM	124.00	103.00	94.00	92.00
Nitrogen, g/kg DM	19.84	16.48	15.04	14.72
Ash, g/kg DM	94.00	108.00	105.00	114.00
Carbon, g/kg DM	503.33	495.56	497.22	492.22
Ratio carbon/nitrogen	25.37	30.25	33.06	33.43
Acid detergent lignin, g/kg DM	36.00	46.00	47.00	57.00
Hemicellulose, g/kg DM	260.00	266.00	278.00	200.00
Biomethane potential, L/kg VS	351.00	331.00	328.00	298.00

Bioenergy is recognized as a renewable energy source because its biomass feedstocks are generated through photosynthesis in plants, a process that absorbs carbon dioxide from the atmosphere. Consequently, bioenergy production plays an important role in reducing greenhouse gas (GHG) emissions by substituting fossil fuels across various sectors, including transportation, heating, and electricity generation. Biomethane, produced via anaerobic digestion of biomass feedstocks such as grass biomass, energy crops, agricultural residues, and forestry waste, shows significant promise as a renewable energy source for mitigating climate change. Additionally, anaerobic digestion in biogas reactors yields a nutrient-rich digestate that can be used as a sustainable organic fertilizer, contributing to closed nutrient cycles and supporting regenerative agricultural practices. This also has the potential to enhance farm economics by lowering the cost of chemical fertilizers. For optimal anaerobic digestion, methanogenic bacteria require a suitable carbon-to-nitrogen (C/N) ratio. Ratios exceeding 30:1 have been found to be suboptimal for efficient digestion. The results related to the biochemical methane production potential of the studied *Bromus* substrates are presented in Table 3. The nitrogen concentration in the tested green mass substrates varied from 16.48 g/kg 19.84 g/kg, the estimated carbon concentration– from 495.56 g/kg to 03.33 g/kg, the C/N = 25.37-30.25, while the hays substrates contained 14.72-15.04 g/kg nitrogen, 492.22-495.56 g/kg carbon and C/N = 30.25-33.43. Among these, green mass from *Bromus inermis* exhibited an optimal C/N ratio for anaerobic digestion. Essential differences were observed between concentrations of acid detergent lignin. As we have mentioned above, the haymaking process increased the acid detergent lignin content, which had a negative effect on the activity of methanogenic bacteria. The *Bromus inermis* hay substrate contained lower concentration of acid detergent lignin and optimal concentration of hemicellulose compared to *Bromus tectorum* substrate. The biochemical methane potential varied from 328 to 351 l/kg VS in green mass substrates and from 298 to 331 l/kg VS in hay mass substrates. The best biomethane potential was achieved from *Bromus inermis* substrates.

Several studies have reported data on the biogas yield and methane potential of substrates derived from *Bromus* species. According to ŻUREK & MARTYNIAK (2020), the *Bromus catharticus* substrate produced a biogas yield of 485 L/kg VS with a methane content of 50.23%. In comparison, the *Bromus inermis* substrate yielded 518.3 L/kg VS with 50.4% methane, while the *Lolium perenne* substrate generated 611.9 L/kg VS with methane content of 54.8%. WALISZEWSKA et al., (2024) reported that *Bromus inermis* substrates contained 38.65% Cel, 29.75% HC, 14.89% lignin, and 8.57% ash, resulting in a biogas yield of 429 L/kg and a methane potential of 232 L/kg. *Bromus hordeaceus* substrates had 36.39% Cel, 36.54% HC, 12.44% lignin, and 6.93% ash, yielding 381 L/kg of biogas and 211 L/kg of methane. In comparison, *Festuca arundinacea* substrates contained 35.56% Cel, 31.87% HC, 17.28% lignin, and 5.39% ash, with a biogas yield of 438 L/kg and a methane potential of 239 L/kg.

CONCLUSIONS

The green mass productivity of studied local ecotypes of *Bromus* species ranged from 1.76 kg/m² to 4.19 kg/m² The quality indices of the harvested green mass dry matter varied across species, with 9.4-12.4% CP, 33.6-37.7% CF, 62.9-64.7% NDF, 36.9-38.8% ADF, 3.6-4.7% ADL, 33.0-34.1% Cel, 26.0-27.8% HC, 13.5-17.9% TSS, 9.4-10.5% ash, 587-602 g/kg DMD, RFV = 84-90, 9.56-9.76 MJ/kg ME and 5.57-5.79MJ/kg NEl.

The prepared hay from the *Bromus* species also demonstrated good nutritional quality, with nutrient content and energy value characterized by such indices as: 9.2-10.3% CP, 10.8-11.4% ash, 36.0-39.9% CF, 38.4-40.7% ADF, 65.0-65.7% NDF, 4.6-5.7 % ADL, 6.2-9.4% TSS, 574-590g/kg DDM, RFV=81-84, 11.41-11.70 MJ/kg DE, 9.37-9.60 MJ/kg ME and 5.39-5.62 MJ/kg NEl.

The biochemical methane potential of the studied *Bromus* substrates ranged from 298 to 351 l/kg VS, confirming their suitability for biomethane production.

The local ecotypes of *Bromus inermis* and *Bromus tectorum* demonstrated favorable nutritional profiles, supporting their dual use as forage for livestock and as substrates for renewable bioenergy production.

In particular, *Bromus inermis* ecotypes stood out due to their higher biomass productivity, high content of crude protein, lower cell wall content, higher dry matter digestibility, metabolizable energy and net energy for lactation as compared with *Bromus tectorum* forage, highlighting its superior value.

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