# THE PROSPECTS OF CULTIVATION AND UTILIZATION OF *Coronilla varia* L. IN MOLDOVA

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**Abstract.** This research was aimed at evaluating some agrobiological peculiarities and the biochemical composition of the harvested fresh mass and hay prepared from a local ecotype of crown vetch, *Coronilla varia*, grown in monoculture in an experimental field of the National Botanical Garden (Institute), Chişinău, Republic of Moldova. It has been found that the studied local ecotype of crown vetch can be mowed 2-3 times per season starting with the second year of life. The dry matter of harvested plants contains 157-167 g/kg CP, 85-110 g/kg ash, 292-342 g/kg CF, 303-353 g/kg ADF, 450-519 g/kg NDF, 51-58 g/kg ADL; the fodder value is 61.42-65.30 % DMD, RFV=110-135, 9.95-10.53 MJ/kg ME and 5.97- 6.54 MJ/kg NEl. Crown vetch hay has a pleasant smell and contains 160 g/kg CP, 90 g/kg ash, 340 g/kg CF, 349 g/kg ADF, 507 g/kg NDF, 56 g/kg ADL, 61.21 % DMD, RFV=113, 9.93 MJ/kg ME and 6.02 MJ/kg NEl. The substrate of crown vetch fresh mass used for anaerobic digestion is characterized by an optimal carbon-nitrogen ratio – C/N = 18.5-20.2, contains 147-166 g/kg hemicellulose, 51-58 g/kg lignin and the biochemical biomethane potential reaches 281-286 l/kg ODM. *Coronilla varia* 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 the harvested mass can be used as natural feed or hay for ruminants, or as a substrate for the production of biomethane and renewable energy.

**Keywords:** biochemical composition, *Coronilla varia*, hay, fresh mass, biomethane potential, fodder quality.

**Rezumat. Perspectiva de cultivare şi valorificare a speciei *Coronilla varia* L. în Moldova.** Scopul cercetării a constatat în evaluarea unor particularităţi agrobiologice, compoziţiei biochimice a masei proaspete recoltate şi a fânului preparat din ecotipul local a speciei *Coronilla varia*, coronişte variată, menţinută în cultură pură în câmpul experimental din Grădina Botanică Naţională (Institut), Chişinău, Republica Moldova. S-a stabilit că ecotipul local de coronişte variată din anul 2 de vegetaţie asigură 2-3 coase anual, materia uscată a plantelor recoltate conţine 157-167 g/kg proteină brută (CP), 85-110 g/kg cenuşă, 292-342 g/kg celuloză brută (CF), 303-353 g/kg fibre în detergent acid (ADF), 450-519 g/kg fibre în detergent neutru (NDF), 51-58 g/kg lignină sulfurică (ADL); valoarea nutritivă – 61.42-65.30 % substanţă uscată digestibilă (DMD), valoare relativă a furajului RFV=110-135, încărcătură energetitică de 9.95-10.53 MJ/kg energie metabolozantă (ME) şi 5.97- 6.54 MJ/kg energie netă lactaţie (NEl). Fânul de coronişte se caracterizează printr-un miros plăcut, conţinut de 160 g/kg CP, 90 g/kg cenuşă, 340 g/kg CF, 349 g/kg ADF, 507 g/kg NDF, 56 g/kg ADL, 61.21 % DMD, RFV=113, 9.93 MJ/kg ME şi 6.02 MJ/kg NEl. Calitiatea substratului pentru digestia anaerobă a masei proaspete recoltate de *Coronilla varia* se caracterizează printr-un raport carbon azot optimal C/N=18.5-20.2, conţinut de hemiceluloză 147-166 g/kg, 51-58 g/kg lignină sulfurică şi potenţialul biochimic de obţinere a biometanului atinge 281-287 l/kg M.O. Coronişte variată, *Coronilla varia* poate fi folosită la recultivarea pajiştilor permanente şi fondarea pajiştilor temporare pentru stoparea proceselor erozionale în cultură pură sau asociată cu alte ierburi, iar masă recoltată valorificată ca furaj natural sau fân pentru animalele rumegătoare, deasemenea ca substrat pentru obţinerea biometanului şi producerea energiei renovabile.

**Cuvinte cheie:** compoziţia biochimică, *Coronilla varia*, fân, masă proaspătă, potenţial de biometan, valoare nutritivă.

## INTRODUCTION

Population growth, arable land scarcity, climate change and energy demands may threaten global food and energy security in the coming decades. Nutritional benefits from ruminants are obvious, as they have the ability to convert fibre-dense forages that are indigestible for humans into high quality bioavailable nutrient sources. In fact, 80-90% of livestock feed is not suitable for human consumption. Animal performance is determined by feed availability, nutrient content, intake, digestibility and metabolizable energy of feed, but availability and intake most often determine animal performance. The quality of the forage is mostly affected by factors such as species, plant maturity, fertilization and soil fertility, growing environment and harvesting conditions.

Grasslands and forage plants have also been used in recent decades as feedstock for renewable energy production and in biorefinery (STODDARD, 2013; HUYGHE et al., 2014; STINNER, 2015).

One of the most commonly known and economically important plant families is *Fabaceae* Lindl. (syn. *Leguminosae* Juss., *Papilionaceae* Giseke). Its species play a critical role in food security, nutrition, medicine and industrial needs. Legume species are well known for their ability to improve soil fertility by the fixation of atmospheric nitrogen and to produce feed and forage containing high amounts of protein. The leaves and stems of forage legumes contain more proteins than other plants when they are harvested at a similar stage of maturity. Legumes not only have a higher percentage of proteins, they also have high quality protein. This is of prime importance and helps greatly in obtaining high nutritive value in feeds for animals. The quality of the protein in legumes makes them particularly valuable as feed to supplement cereal grains lacking the proper amounts of protein for a balanced diet for livestock. *Medicago* and *Trifolium* species are the predominant forage legumes. They are favoured for their high yield, nutritional quality and winter hardiness, but are seldom grazed in pure stands because these species may cause bloat in ruminants. Some forage legumes, e.g., sainfoin - *Onobrychis viciifolia* Scop., birdsfoot trefoil - *Lotus corniculatus* L., cicer milkvetch - *Astragalus cicer* L. and crown vetch - *Coronilla varia* L., containing moderate concentrations of condensed

tannins, confer bloat resistance, increased flow of non-ammonia N and essential amino acids to the small intestine, and increased plasma levels of sulphur amino acids for body synthetic reactions. Some legume species offer opportunities for improving animal health with less medication, due to the presence of bioactive secondary metabolites (ARCIONI et al., 1988; TERRILL et al., 1992; MUELLER-HARVEY, 2006; BERARD et al., 2011; LUSCHER et al., 2013; ROCA-FERNÁNDEZ et al., 2020).

The genus *Coronilla* L., Coronilleae tribe, contains about 20 species native to Europe and North Africa (SOKOLOFF, 2003). 2 species are present in the spontaneous flora of the Republic of Moldova: *Coronilla elegans* Pancic (synonym *Coronilla latifolia* (Hazsl.) Jav.) and *Coronilla varia* L. (syn. *Securigera varia* (L.) Lassen). *Coronilla varia* is the most widespread of these species (NEGRU, 2007). *Coronilla varia* commonly known as crown vetch or purple crown vetch is an herbaceous perennial plant, spreading to diffuse stems that can measure up 0.3 to 1.8 meters long, deeply tap-rooted with numerous lateral roots, spreading via rhizomes which penetrate the soil to 2 m deep. Leaves are 5-10 cm long, deep green, alternate compound pinnate with 9 to 25 oblong to elliptic leaflets 1-2 cm long, have smooth margins with small points at the tips. Racemes are umbrella-shaped, 15-20-floral, located on flower stalks exceeding leaves, variegated in colour from white and purple. Pods are indehiscent, may reach 2-6 cm long, with 3-7 cylindrical segments each containing one ovate-oblong, yellow-orange to reddish-brown rod-shaped seed, 3-3.5 mm in length and 1-1.5 mm in width. The weight of 1000 seeds is 3.64–4.06 g. It has a karyotype 2n = 24 and a high proportion of seeds are hard. Seeds remain viable in the ground for 15 years (FRAME, 2005; LUNEVA, 2008; GUCKER, 2009).

*Coronilla varia* was characterized by slow germination, seedling emergence and a development rate in the first year similar to *Trifolium pratense*, *Lotus corniculatus* or *Medicago sativa* (PEIFFER et al., 1972). *Coronilla varia* can grow in soils with pH = 5-7.5 and low fertility, is tolerant to low temperatures (down to -33 °C) and can withstand periods of drought as well, but is intolerant to salty and solonchak, waterlogged soils. Crown vetch produces extensive vegetative growth from multibranched rhizomes and is capable of regenerating from stem and rhizome fragments. GUCKER (2009) reports the species as "long-lived" up to 20 years, with some plants surviving at the same location for over 50 years. Crown vetch has been extensively planted for erosion control along many roads, highways and disturbed areas. It has also been widely planted for ground cover, mine reclamation and as a cover crop as it provides nitrogen to soil through its association with cyanobacteria (HOFBAUER, 1977; BARNES & DEMPSEY, 1992; LI et al., 2016). *Coronilla varia* may be used for phytoremediation of organic pollutants and has abilities to stimulate dissipation of PCB, TNT and pyrene in soil (KUDJO et al., 2000). The plant mixtures of mustard, buckweat, sainfoin, melilot and coronilla have demonstrated a weed suppressive effect and had a long flowering period, which begins at the end of May, providing a rich source of nectar that attracts the honeybees and wild bees living on the nearby territories (SZALAI et al., 2001). *Coronilla varia* is a source of phytochemicals with cardiac, diuretic, purgative, antibacterial and anticancer activity (AL-SNAFI, 2016; DEHPOUR et al., 2014).

In recent decades, crown vetch *Coronilla varia* has been considered a source of forage for livestock. Information about the acceptability and nutritive value of crown vetch is still limited. It is best adapted for pasture because of its prostrate growth habit and non-bloating characteristic. Recently, it has been deemed as good forage when fed as hay to or be grazed by ruminant animals such as cattle, goats, sheep, elk and deer. Some research has indicated that the young plants are palatable but that more mature plants are not readily accepted. In other grazing trials, animals were slow to accept it, but after a few days, their performance on crown vetch was comparable to that of other common grass-legume pastures. If harvested for hay, two harvests per season produce the greatest yields (ACAR et al., 2001; FRAME, 2005; MUELLER-HARVEY, 2006; LUNEVA, 2008; MESSMAN et al., 1994; GUCKER, 2009). In some papers, it was mentioned that the productivity of *Coronilla varia* under the climatic conditions of Russia reached 65 t/ha green mass (DRONOVA et al., 2009); in South Africa, crown vetch yielded 10.6 t/ha of dry matter, but alfalfa – 7.1 t/ha (LE ROUX et al., 1988). The presence of aliphatic nitro compounds makes *Coronilla varia* may be toxic to horses and other non-ruminants (CASLER & UNDERSANDER, 2019*).*

This research was aimed at evaluating some agrobiological peculiarities and biochemical composition of *Coronilla varia* green mass and hay and the possibility of using it as fodder for ruminant animals or as biogas substrate for renewable energy production.

## MATERIAL AND METHODS

The local ecotype of crown vetch, *Coronilla varia*, maintained in monoculture in the experimental plot of the National Botanical Garden (Institute), Chişinău, N 46°58′25.7″ latitude and E 28°52′57.8″ longitude, served as subject of the research, while the traditional leguminous fodder crops: alfalfa, *Medicago sativa*, and common sainfoin, *Onobrychis viciifolia*, were used as control variants. The first cut green mass was harvested in the flowering stage, at the end of May, and the second harvest was done at the end of July. The green mass productivity was determined by weighing the yield obtained from a harvested area of 10 $m^2$. The leaf/stem ratio was determined by separating leaves and flowers from the stem, weighing them separately and establishing the ratios for these quantities, samples of 1.0 kg of harvested plants were taken. For chemical analyses, the samples were dried at 65 ± 5°C. The dry matter content was detected by drying samples up to constant weight at 105 °C. The prepared hay was dried directly in the field. Some assessments of the main biochemical parameters: crude protein (CP), crude fibre (CF), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF) and acid detergent lignin (ADL) have been determined by near infrared spectroscopy (NIRS)

technique, using the PERTEN DA 7200 at the Research and Development Institute for Grassland of Braşov, Romania. The concentration of hemicellulose (HC) and cellulose (Cel), the digestible dry matter (DDM), the relative feed value (RFV), the digestible energy (DE), the metabolizable energy (ME) and the net energy for lactation (NEl) were calculated according to standard procedures.

The biochemical biogas potential (Yb) and the methane potential (Ym) were calculated according to the equations of DANDIKAS et al., (2014) based on the chemical compounds – acid detergent lignin (ADL) and hemicellulose (HC):

Yb = 727+ 0.25 HC- 3.93 ADL

Ym = 371+ 0.13HC - 2.00ADL.

## RESULTS AND DISCUSSIONS

As we mentioned in our previous study (ŢÎŢEI et al., 2016) the emergence of *Coronilla varia* plantlets was uneven and required a 10-17 day longer period as compared with *Medicago sativa* and *Onobrychis viciifolia*. *Coronilla varia* developed in underground part an extensive tap root system and strong fleshy rhizomes, extending down to 70-80 cm. The growth and development rate of the aboveground part was slow, the plants developed an erect stem by August, in the flowering stage it was 37-41 cm tall. In the first growing season, alfalfa was harvested twice, common sainfoin and crown vetch – once. The fresh mass yield of crown vetch was 1.59 kg/m$^2$, with a high content of leaves (68%). The next years, in spring, when the average temperatures were above 5 °C, the growing season of *Coronilla varia* started, shoots developed from large buds, which were located just above the collar. The overwintered rhizomes emerged in spring to initiate new shoots, which after some time took root and became independent plants. The shoots of *Coronilla varia* were decumbent to ascending, up to 120-125 cm long in the flowering stage, while the shoots of traditional leguminous forage crops reached only 83.20-85.50 cm. *Coronilla varia* produced considerable foliage (59-63%) and the fresh mass yield at the first cut reached 3.44-4.06 kg/m$^2$, at the same level as sainfoin and by 22-25% more than alfalfa. After the first cut, the regeneration and development rates of *Coronilla varia* plants were slow in comparison with *Medicago sativa,* but optimal in comparison with *Onobrychis viciifolia.* The new *Coronilla varia* shoots had a prostrate growth habit, were thin and over 62-65 cm long, with a high proportion of leaves (71%) and dry matter content (28.3%). Crown vetch was cut for the second time in late July, obtaining 1.31 kg/m$^2$ fresh mass or 0.37 kg/m$^2$ dry matter. The regeneration of crown vetch plants was very slow, and the new shoots reached only 15 cm by October.

Analysing the results of the green mass quality of *Coronilla varia* (Table 1), we found that the dry matter contained 157-1167 g/kg CP, 292-342 g/kg CF, 85-110 g/kg ash, 292-342 g/kg CF, 303-353 g/kg ADF, 450-519 g/kg NDF, 51-58 g/kg ADL; the fodder value was 61.42- 65.30% DMD, RFV=110-135, 9.95-10.53 MJ/kg ME and 5.97-6.54 MJ/kg NEl. The concentrations of crude protein and ash were high in the second cut natural fodder. The amounts of carbohydrates and lignin decreased substantially in the second cut fodder, which had a positive effect on dry matter digestibility, relative feed value and energy content. We would like to mention that the first cut green mass of *Coronilla varia* contained low amounts of crude protein and minerals, but a high concentration of cell wall components, in comparison with *Onobrychis viciifolia*. The biochemical composition and the fodder quality of first cut *Coronilla varia* did not differ significantly from *Medicago sativa*. The second cut green mass of *Coronilla varia* had approximatively the same level of structural carbohydrates, relative feed value and energy concentration as *Onobrychis viciifolia*.

Table 1. The biochemical composition and the feed value of the green mass from the studied species.

| **Indices** | ***Coronilla varia*** | | ***Onobrychis viciifolia*** | | ***Medicago sativa*** |
|---|---|---|---|---|---|
| | I cut | II cut | I cut | II cut | **I cut** |
| Crude protein, g/kg DM | 157 | 167 | 177 | 172 | 172 |
| Crude fibre, g/kg DM | 342 | 292 | 293 | 279 | 331 |
| Ash, g/kg DM | 85 | 110 | 96 | 104 | 91 |
| Acid detergent fibre, g/kg DM | 353 | 303 | 309 | 302 | 347 |
| Neutral detergent fibre, g/kg DM | 519 | 450 | 447 | 445 | 510 |
| Acid detergent lignin, g/kg DM | 58 | 51 | 49 | 47 | 58 |
| Dry matter digestibility, % | 61.42 | 65.30 | 64.83 | 65.37 | 61.86 |
| Digestible energy, MJ/kg DM | 12.12 | 12.82 | 12.74 | 12.84 | 12.21 |
| Metabolizable energy, MJ/kg DM | 9.95 | 10.53 | 10.46 | 10.54 | 10.02 |
| Net energy for lactation, MJ/kg DM | 5.97 | 6.54 | 6.47 | 6.56 | 6.04 |
| Relative feed value | 110 | 135 | 135 | 137 | 113 |

Some authors have mentioned various findings about the quality of *Coronilla varia* fodder. REYNOLDS et al., (1967) reported that crown vetch forage contained 21.7% protein and 22.2% fibre, and its digestibility in sheep was 65.6% protein and 46.2% fibre, but slightly less than the digestibility of alfalfa forage. SHEAFFER& MARTEN (1991) mentioned that harvested *Coronilla varia* plants contained 168-242 g/kg CP and 557-700 g/kg IVDDM, but *Medicago sativa* – 156-224 g/kg CP and 560-673 g/kg IVDDM and *Trfolium ambiguum* – 178-230 g/kg CP and 672-765 g/kg IVDDM. GERVAIS (2000) found that the chemical composition and the nutritive value of *Coronilla varia* were 158.7-194.3 g/kg CP, 406.6- 458.1 g/kg NDF, 267.5-325.3 g/kg ADF and 587-635 g/kg digestible matter. ACAR et al., (2001) remarked than *Coronilla varia* spp. *varia* cultivated in Pakistan contains on average 14.86% CP, 9.99% ash, 22.2 g/kg

calcium, 22.4 g/kg potassium, 1.88 g/kg magnesium, 14.46 mg/kg copper, 67.35 mg/kg zinc, 40.37 mg/kg manganese, 482.6 mg/kg iron. KSHNIKATKINA et al., (2005) reported that the crown vetch forage harvested in the budding stage contained 255.3 g/kg protein, 30.2 g/kg fat, 150.0 g/kg cellulose, 40 g/kg calcium, 8 g/kg phosphorus, 0.6 g/kg magnesium, 2.48 mg/kg copper, 14 mg/kg zinc, 49 mg/kg manganese, 105 mg/kg iron. According to DRONOVA et al., (2009), the chemical composition of crown vetch dry matter was: 25.2% protein, 3.3% fat, 25.5% cellulose, 34.3% nitrogen free extract, but alfalfa – 21.8%, 2.3%, 22.0% and 35.0%, respectively. TELEUTSE & TSYTSEY (2012) reported that the *Coronilla varia* green mass contained 19.0% crude protein, 1.6% crude fats, 37.7% crude cellulose, 6.6% ash, while the *Medicago sativa* green mass contained 17.4% crude protein, 0.8% crude fats, 24.0% crude cellulose, 7.8% ash. MAHDAVI et al., (2015) compared the feed quality of green mass selected at different growth stages from different vegetation types in Iran and found that *Coronilla varia* contained 18.87-26.28% CP, 21.70-50.47% NDF and 11.51-32.43% ADF, but *Medicago sativa* – 13.83-28.87% CP, 23.12-46.14% NDF and 18.23-36.29% ADF. According to the results obtained at the Dickinson Research Extension Centre of North Dakota State University, *Coronilla varia* green mass had 23% dry matter with 17% CP, 38% NDF, 32% ADF, 64% TDN, RFV=159, 0.34% P and 1.28% Ca. TAYSUMOV et al., (2018) reported that *Coronilla varia* and *Galega orientalis* contained 16.0-16.4% CP, and animals eat it satisfactorily.

The use of forage conservation methods to supply roughage to herbivores at critical times of production is an excellent strategy in animal production. Hay plays an important role in the ruminant feeding system as it represents a low-cost and abundant source of dry matter, is vital to keep animals healthy and to protect their digestive health. The organoleptic hay quality is indicated by colour, dust content, smell and leafiness. Hay that is greener in colour is likely to have a higher concentration of vitamins, such as vitamin A and D, as well as more nutrients. Typically, legume varieties have more leaves, and leaves contain more nutrients than stems due to a lower amount of structural carbohydrates. Good legume hay has many characteristics that make it of special value to the dairy cattle. It has a higher percentage of digestible nutrients, calcium, phosphorus and magnesium. Well-cured legume hays are higher in carotene contents, are rich sources of vitamin E, and may even contain vitamin D.

As for the organoleptic properties of the first cut hay prepared from the studied legume species, we could mention that *Coronilla varia* hay consists of dark green leaves and greenish stems, has pleasant smell, the leaves remain attached to the stems, and has a reduced dust content. The *Onobrychis viciifolia* hay has a pleasant smell, consists of greyish-green leaves and whitish-green stems, the leaves stay attached to the stems, without dusty content. The nutrient profile of the investigated legume hays is presented in Table 2. *Coronilla varia* hay was characterized by 160 g/kg CP, 340 g/kg of CF, 90 g/kg ash, 349 g/kg ADF, 507 g/kg NDF, 56 g/kg ADF, 292 g/kg Cel, 158 g/kg HC. The nutritive value and energy concentration of *Coronilla varia* hay reached 61.21% DMD and RFV=110, 12.09 MJ/kg DE, 9.93 MJ/kg ME and 6.02 MJ/kg NEl. The average values indicate similarities in fibre, protein and energy concentration between crown vetch hay and common sainfoin hay.

Table 2. Biochemical composition and feed value of hay from the studied species.

| **Indices** | ***Coronilla varia*** | ***Onobrychis viciifolia*** |
|---|---|---|
| Crude protein, g/kg DM | 160 | 163 |
| Crude fibre, g/kg DM | 340 | 338 |
| Ash, g/kg DM | 90 | 99 |
| Acid detergent fibre, g/kg DM | 349 | 350 |
| Neutral detergent fibre, g/kg DM | 507 | 499 |
| Acid detergent lignin, g/kg DM | 56 | 52 |
| Cellulose, g/kg DM | 292 | 298 |
| Hemicellulose, g/kg DM | 158 | 149 |
| Dry matter digestibility, % | 61.21 | 61.63 |
| Digestible energy, MJ/kg DM | 12.09 | 12.17 |
| Metabolizable energy, MJ/kg DM | 9.93 | 9.99 |
| Net energy for lactation, MJ/kg DM | 6.02 | 6.01 |
| Relative feed value | 113 | 115 |

The information about the nutritive value of crown vetch hay is still limited. SEIM (1966) found that *Coronilla varia* hay contained 17.1-17.7% CP and 61.3-62.1% IVDMD. MESSMAN et al., (1994) compared the protein concentration in forage and reported that *Coronilla varia* contained 27% CP in fresh mass and 29.7% CP in hay, *Medicago sativa* – 24.3% CP in fresh mass and 26.9% CP in hay, respectively.

Biogas production by anaerobic fermentation technology strongly increased in last few years. Since biogas production is independent of weather conditions and diurnal cycles, it is a very attractive component in the mixture of renewable energy sources. Biomethane derived from anaerobic digestion can be utilised in the same manner for applications such as heat production, electricity generation and as a compressed natural gas (CNG) transport fuel. The potential of this type of energy production from biomass is huge. The use of forage legumes as biogas substrate contributes to an increase in the potential of bioenergy and can help reduce the greenhouse gas emissions. Through symbiotic nitrogen fixation, they compensate the inorganic N fertilizer in conventional farms, if the digestate is applied as a fertilizer to the non-legume crops (STODDARD, 2013; STINNER, 2015). Foam formation is considered one of the most frequent disturbances in biogas reactors. Using mixtures of legumes and tannin-containing plants, such as sainfoin

(*Onobrychis viciifolia*), birdsfoot trefoil (*Lotus corniculatus*), crown vetch (*Coronilla varia*), cicer milkvetch (*Astragalus cicer*) and bitter dock (*Rumex obtusifolius*), can minimize foam formation in biogas reactors with a beneficial effect on methane production yield and environmental protection (MOELLER et al., 2012).

During the anaerobic digestion, the carbon to nitrogen ratio (C/N ratio) has effects on methane production yield and is a very important factor for the stable operation. When the C/N ratio is too high, biogas yield does not show optimal results because acidogenic bacteria rapidly consume nitrogen as compared with methanogenic bacteria. When the C/N ratio is too low, most microbes rapidly consume nitrogen for growth. This has a positive effect on the methane production rate, however, the lack of carbon results in a decrease in acid formation, nitrogen accumulates in the form of ammonium ions (NH4) that increase the pH, which adversely affects biogas production. The optimal C/N ratio in biomass substrate should range from 10 to 30, which will not affect the development of microflora involved in anaerobic digestion. The results regarding the quality of the investigated legume substrates and the potential biomethane are illustrated in Table 3. The nitrogen content in the legume substrates studied by us ranged from 25.12 g/kg to 28.32 g/kg, the estimated content of carbon – from 494.44 g/kg to 508.33 g/kg, the C/N ratio varied from 17.73 to 20.24. Essential differences were observed between the contents of cellulose, hemicellulose and lignin. The first cut green mass substrates from *Coronilla varia* and *Medicago sativa* contained high amounts of cellulose, hemicellulose and lignin in comparison with *Onobrychis viciifolia,* which had negative effect on degradation and biomethane production potential. The biochemical methane potential of *Coronilla varia* substrate reached 281 l/kg ODM, but *Onobrychis viciifolia* substrate – 291 l/kg ODM and *Medicago sativa* – 276 l/kg ODM. The second cut *Coronilla varia* substrate contained higher amounts of lignin and acceptable amounts of hemicellulose, in comparison with the *Onobrychis viciifolia* substrate, the biomethane yield reached 286 l/kg ODM and 296 l/kg ODM, respectively.

In our previous study, we found that the biogas production potential of the fermentable (digestible) organic matter from *Coronilla varia* reached 501 l/kg, *Medicago sativa* – 514 l/kg and *Onobrychis viciifolia* – 526 l/kg, the methane yield was 263 l/kg, 270 l/kg and 276 l/kg, respectively (TELEUŢĂ & ŢÎŢEI, 2016).

Table 3. The biochemical biogas and biomethane production potential of the investigated green mass substrates.

| Indices | *Coronilla varia* | | *Onobrychis viciifolia* | | *Medicago sativa* |
|---|---|---|---|---|---|
| | I cut | II cut | I cut | II cut | I cut |
| Crude protein, g/kg DM | 157 | 167 | 177 | 172 | 172 |
| Ash, g/kg DM | 85 | 110 | 96 | 104 | 91 |
| Nitrogen, g/kg DM | 25.12 | 26.72 | 28.32 | 27.72 | 27.72 |
| Carbon, g/kg DM | 508.33 | 494.44 | 502.22 | 497.78 | 505.00 |
| Ratio carbon/nitrogen | 20.24 | 18.50 | 17.73 | 17.95 | 18.22 |
| Acid detergent lignin, g/kg DM | 58 | 51 | 49 | 47 | 58 |
| Cellulose, g/kg DM | 295 | 252 | 260 | 255 | 289 |
| Hemicellulose, g/kg DM | 166 | 147 | 138 | 143 | 163 |
| Biogas potential, L/kg ODM | 549 | 564 | 548 | 578 | 540 |
| Biomethane potential, L/kg ODM | 281 | 286 | 291 | 296 | 276 |

## CONCLUSIONS

A local ecotype of crown vetch, *Coronilla varia* can be mowed 2-3 times per season, while the fresh mass yield at the first cut achieved 4.06 kg/m$^2$ and reached 1.31 kg/m$^2$ in second cut.

The dry matter of harvested *Coronilla varia* plants contains 157-167 g/kg CP, 85-110 g/kg ash, 292-342 g/kg CF, 303-353 g/kg ADF, 450-519 g/kg NDF, 51-58 g/kg ADL, 147-166 g/kg HC and 252-295 g/kg Cel.

The fodder value of the *Coronilla varia* fresh mass is 61.42- 65.30 % DMD, RFV=110-135, 12.12-12.82 MJ/kg DE, 9.95-10.53 MJ/kg ME, and 5.97-6.54 MJ/kg NEl.

The prepared hay from *Coronilla varia* has a pleasant smell and contains 160 g/kg CP, 90 g/kg ash, 340 g/kg CF, 349 g/kg ADF, 507 g/kg NDF, 56 g/kg ADL, 61.21 % DMD, RFV=113, 9.93 MJ/kg ME and 6.02 MJ/kg NEl.

The substrates of crown vetch fresh mass used for anaerobic digestion are characterized by an optimal carbon-nitrogen ratio – C/N = 18.5-20.2, contain 147-166 g/kg hemicellulose, 51-58 g/kg lignin and the biochemical biomethane potential reaches 281-286 l/kg ODM.

A local ecotype of crown vetch, *Coronilla varia* 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 the harvested mass can be used as natural feed or hay for ruminants, or as a substrate for the production of biomethane and renewable energy.

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