J. Plant Develop.
23(2016): 27-35

ECONOMIC VALUE OF SOME LEGUMINOUS PLANT SPECIES OF THE COLLECTIONS FROM THE BOTANICAL GARDEN (INSTITUTE) OF THE ACADEMY OF SCIENCES OF MOLDOVA

Alexandru TELEUȚĂ[1*], Victor ȚÎȚEI[1]

Abstract: The results of the evaluation of the growth and development rates, the seed productivity, the green mass yield, the biochemical composition and the content of amino acids, phosphorous and calcium, the nutritive and energy value of the forage, as well as the biomethane productivity of local ecotypes of the leguminous species maintained in monoculture, in the collection of the Botanical Garden (Institute) of the Academy of Sciences of Moldova (BG ASM): *Astragalus ponticus*, *Coronilla varia*, *Lotus corniculatus*, *Medicago falcata*, *Onobrychis arenaria* and *Trifolium repens* are presented in this article. Control variants – the traditional forage crops: *Medicago sativa* and *Onobrychis viciifolia.*
The local ecotypes of the studied leguminous species were characterized by different growth and development rates. *Coronilla varia* and *Lotus corniculatus*, in the 2nd-3rd years, could be harvested, for the first time, 5 days earlier than *Medicago sativa*, but *Medicago falcata* and *Onobrychis viciifolia* – 18 days later. The green mass yield varied from 0.83 kg/m^2 to 4.08 kg/m^2. The studied ecotypes reached amounts of 0.60-0.89 nutritive units/kg and metabolizable energy 8.05-9.90 MJ/kg of dry matter, the content of digestible protein, of 106.28-225.09 g/nutritive unit, met the zootechnical standards; seed production: 19.12-83.00 g/m^2; the biomethane yield ranged from 692 to 3197 m^3/ha.
Higher yield of natural forage, dry matter and biomethane was produced by *Onobrychis arenaria* and *Coronilla varia*.

Keywords: biochemical composition, biological peculiarities, economic value, perennial leguminous species.

Introduction

Legumes from pastures and meadows contribute nitrogen to a complex and dynamic recycling system, organic matter containing legume proteins may be mineralized in soil, liberating N as nitrates (NO_3) and NH_4 that may be used by grasses and other species of plants. They are important in livestock feeding systems because they have the potential to extend the grazing season, increase the quantity of grazed forage and hay, and reduce the amount of N fertilizer needed. Legume feed not only improves forage quality but also increases the intake of the ration, hence, gives better performance in terms of livestock production. Many legume crops are also excellent honey plants, other plants can be used as raw material in various branches of the national economy, as they are for cosmetology, pharmaceutics and bioenergetics industry [DUKE, 1981; STODDARD, 2013].

The spontaneous flora of the Republic of Moldova (RM) is relatively rich and includes 5568 species of plants (superior plants – 2044 species, inferior plants – 3524 species), family *Fabaceae* Lindl. – 25 genera and 120 species [NEGRU, 2007]. The spontaneous flora of our country includes over 700 species of fodder plants and 71 species of them are leguminous plants [TELEUȚĂ, 2010]. The grasslands from the Republic of Moldova cover about 14% of the

[1] Botanical Garden (Institute) of the Academy of Sciences of Moldova, 18 Pădurii str., 2002, Chișinău – Republic of Moldova.
[*] Corresponding author. E-mail: ateleuta@gmail.com

territory, they are in a deplorable condition and have very low productivity, with a share of leguminous plants decreasing from year to year [BANCIVANJI & al. 2012].

The collection of non-traditional forage plants of the Botanical Garden (Institute) of the Academy of Sciences of Moldova have 320 botanical taxa (species, varieties), including 73 leguminous plants [TELEUȚĂ, 2010; TELEUȚĂ & ȚÎȚEI, 2012; 2016].

This research was aimed at evaluating the biological peculiarities, the biochemical composition of the local ecotype of leguminous plant species and the possibility to use them as forage for ruminant animals or as biogas substrate.

Materials and methods

The seeds of the native leguminous species (*Astragalus ponticus* Pall., *Coronilla varia* L., *Lotus corniculatus* L., *Medicago falcata* L., *Onobrychis arenaria* (Kit.) DC., *Trifolium repens* L.) served as subjects of study and were collected from the spontaneous flora of the main botanical district from RM (region of plains of Balti and Bugeac steppe), maintained in monoculture in the collection of new and non-traditional forage plants of the BG ASM. The traditional forage crops (*Medicago sativa* L. cv. *Ilan* and *Onobrychis viciifolia* Scop. cv. *Adam*) served as control variants. The green mass and the samples for biochemical analysis were gathered after the first mowing, in the budding-flowering period. The scientific research on growth and development, yield and biochemical composition of the plants, was carried out according to the methodical indications [NOVOSIOLOV & al. 1983; PETUKHOV & al. 1989].

The carbon content of the substrates was determined by the data on volatile solids (organic dry matter), using an empirical equation [BADGER & al. 1979]. The biogas production potential and the specific methane yields were evaluated by the parameter "content of fermentable organic matter" [WEISSBACH, 2008].

Results and discussion

As a result of the phenological observations, it has been found that, in the first growing season, the studied perennial leguminous species are characterised by different growth and development rates. Thus, it has been determined that the plantlets of *Trifolium repens* and *Medicago falcata* emerge uniformly at the soil surface, 14 days after sowing, 3 days earlier as compared with the control, *Medicago sativa*, and 9 days earlier as compared with *Onobrychis viciifolia*. The plantlets of the species: *Astragalus ponticus*, *Lotus corniculatus* and *Onobrychis arenaria* emerge after 20 days, so, they need the same period of time as *Onobrychis viciifolia*, but the plantlets of *Coronilla varia* emerge the latest, that is, about 26 days after sowing or 12 days later as compared with *Medicago sativa.* The plants of *Astragalus ponticus* and *Coronilla varia* are distinguished by a very slow growth and development of the aerial part. By the end of the growing season, *Astragalus ponticus* develops the rosette with leaves, and *Coronilla varia* reaches the budding stage and the beginning of the flowering stage. The species *Lotus corniculatus*, *Medicago falcata*, *Onobrychis arenaria* and *Trifolium repens* pass through all the ontogenetic stages. The species *Lotus corniculatus* and *Onobrychis arenaria* are characterised by faster development rates, the development and the ripening of seeds start 7 days earlier, in comparison with *Onobrychis viciifolia* and *Trifolium repens*, 32 days earlier, in comparison with *Medicago sativa* and 39 days earlier than *Medicago falcata.*

In the following years, the leguminous species, studied by us, resume their growth and development in spring, when temperatures above 3-5 °C are established. The species *Trifolium repens* and *Medicago falcata* resume growth 7 days earlier than *Astragalus ponticus* and 3 days earlier than other species. The species: *Lotus corniculatus, Astragalus ponticus* and *Trifolium repens* are characterised by a faster development during the whole growing season, but they don't grow as tall as the traditional leguminous crops. So, by the end of April (Tab. 1), the plants reach 22.00-27.20 cm high, while the control species – about 35.90-38.10 cm. The shoots of *Coronilla varia*, in this period, reach a height of 47.20 cm.

Tab. 1. Duration of periods of growth and plant height of the studied species

Indicators	*Astragalus ponticus*	*Coronilla varia*	*Lotus corniculatus*	*Medicago falcata*	*Medicago sativa*	*Onobrychis arenaria*	*Onobrychis viciifolia*	*Trifolium repens*
Resumed vegetation up to:	17.03	13.03	13.03	10.03	13.03	13.03	13.03	10.03
- budding	66	70	63	78	75	73	75	71
- flowering	77	77	77	101	82	80	99	82
- seed ripening	117	141	121	158	143	128	133	119
Plant height, cm								
- at the end of April	27.20	47.20	26.70	31.03	38.10	37.00	35.90	22.00
- at flowering	76.0	122.10	42.31	72.00	83.20	95.07	85.50	31.30

It has been determined that the period of time from the restart of active growth until the flower bud formation, in *Lotus corniculatus*, constitutes 63 days, in *Medicago falcata* – 78 days, but in the control species – 75 days. The flowering stage of *Astragalus ponticus, Coronilla varia, Lotus corniculatus* and *Trifolium repens* starts 22 days earlier in comparison with *Onobrychis viciifolia* and 5 days – in comparison with *Medicago sativa*. The plants of *Medicago falcata* begin to bloom the last.

During the flowering stage, the shoots of *Coronilla varia* and *Onobrychis arenaria* reach 95.07-122.10 cm high, *Trifolium repens* and *Lotus corniculatus* – 31.30-42.31 cm, but the control – 83.20-85.50 cm.

The studied species need a different period of time from the beginning of flowering until the full ripening of seeds. So, *Trifolium repens, Astragalus ponticus* and *Lotus corniculatus* need 37-44 days, *Medicago falcata* and *Coronilla varia* – 57-64 days, while *Onobrychis viciifolia* needs 34 days and *Medicago sativa* – 61 days.

Seed production is a key pillar in the capacity of maintenance and expansion of the species. Analysing the seed productivity (Tab. 2), we conclude that the studied leguminous forage species differ from *Medicago sativa* and *Onobrychis viciifolia* in the quantity of produced seeds and in the weight of 1000 seeds. The plants of the genus *Onobrychis* (83.00-112.23 g/m^2) and *Astragalus ponticus* (40.90 g/m^2) are characterised by high seed productivity, the mass of 1000 seeds of these species is also quite high (8.44-14.09 g). The plants of *Lotus corniculatus* and *Trifolium repens*, even if they have lower seed productivity in comparison with the control species, produce the highest number of seeds – about 21 000-27 000 seeds/m^2.

We have also found that *Medicago falcata* produces more seeds than *Medicago sativa*, and *Onobrychis arenaria* – fewer than *Onobrychis viciifolia*.

The total yield, the quality and the seasonal distribution of forage may be of greater importance to the livestock producer. As mentioned above, the studied leguminous forage species have different growth and development rates that influence the productivity of natural forage and the dry matter content. Thus, a higher yield of natural forage and dry matter, in comparison with the controls, was produced by *Onobrychis arenaria* (4.08 kg/m^2 or 1.11 kg/m^2) and *Coronilla varia* (3.92 kg/m^2 or 0.87 kg/m^2), a lower one – by *Trifolium repens*, *Astragalus ponticus* and *Lotus corniculatus* (0.83-1.58 kg/m^2 or 0.28-0.55 kg/m^2). *Onobrychis arenaria* is distinguished by a higher productivity of natural forage and dry matter as compared with *Onobrychis viciifolia*, and *Medicago falcata* – by a lower one as compared with *Medicago sativa.* 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 & al. 2009]. The ecotypes of *Onobrychis arenaria* from Russia are characterized by longer lifespan (5-7 years), in comparison with *Onobrychis viciifolia*, and by higher productivity of forage – with 20-70% [MEDVEDEV & SMETANNIKOVA, 1981].

The low productivity of local ecotypes of *Trifolium repens, Astragalus ponticus* and *Lotus corniculatus* may be explained by the arid environmental conditions (low humidity, rainfall under 400 mm and high temperatures in spring) in recent years. The varieties of *Trifolium repens* and *Lotus corniculatus*, created in Romania and cultivated in areas with 600-1000 mm of precipitation per year, have a production potential of 35-55 t/ha of green mass or 8-12 t/ha of hay [MARUȘCA & al. 2011].

It is well known that cattle eat mainly leaves, due to their high content of nutrients, and the ratio leaves/stems influences the forage value. The forage of *Coronilla varia* and *Astragalus ponticus* is characterized by a high content of leaves (56-63%), but *Medicago falcata* – by a lower one (37%).

Tab. 2. The productivity of the studied species of the family *Fabaceae*

Species	fresh mass, kg/m^2	dry matter, kg/m^2	leaf content, %	seed production, g/m^2	weight of 1000 seeds, g
1	2	3	4	5	6
1. *Astragalus ponticus*	1.48	0.40	56	40.90	8.44
2. *Coronilla varia*	3.92	0.87	63	19.00	3.54
3. *Lotus corniculatus*	1.58	0.55	49	22.30	1.05
4. *Medicago falcata*	2.04	0.66	37	17.00	1.33
5. *Medicago sativa*	3.11	0.82	44	27.14	2.67
6. *Onobrychis arenaria*	4.08	1.11	40	83.00	12.15
7. *Onobrychis viciifolia*	3.95	1.03	39	112.23	14.09
8. *Trifolium repens*	0.83	0.28	41	19.12	0.71

For growth, development, reproduction, as well as for the production of high quality milk or meat, cattle need many nutrients they receive from feed. Proteins are the most important and the largest group of natural macromolecular compounds, essential for life, are a source of nitrogen for the body and play a crucial role in the use of the genetic productive potential. The forage of *Astragalus ponticus* (Tab. 3), is characterised by a high content of raw protein, 23.40% of dry matter, in comparison with *Medicago sativa* and *Onobrychis viciifolia*, while *Trifolium repens* and *Lotus corniculatus* have low content of raw protein. *Astragalus ponticus* is distinguished by a very high content of raw protein (63.84 g/kg), which

is 67-75% higher compared to the species *Trifolium repens* and *Lotus corniculatus.* A high capacity of nitrogen accumulation by *Astragalus ponticus* is also recorded in other papers [DAVIS, 1982]. The species *Coronilla varia* and *Medicago falcata* are at the same level, regarding the content of raw protein. Other authors [ACAR & al. 2001], remarked that *Medicago falcata* and *Coronilla varia* contain 14.58-14.86% raw protein, but *Lotus corniculatus* and *Trifolium repens* – 17.87-18.93% raw protein.

Tab. 3. Biochemical composition and nutritional value of the dry matter of the studied species of the family *Fabaceae*

Indicators	***Astragalus ponticus***	***Coronilla varia***	***Lotus corniculatus***	***Medicago falcata***	***Medicago sativa***	***Onobrychis arenaria***	***Onobrychis viciifolia***	***Trifolium repens***
1	2	3	4	5	6	7	8	9
1. Raw protein, %	23.40	14.72	10.50	14.87	17.03	17.38	17.44	11.38
2. Raw fats, %	2.75	2.81	3.20	1.78	2.30	3.55	3.39	2.10
3. Raw cellulose, %	31.90	35.46	28.60	31.20	33.31	29.80	33.50	42.00
4. Nitrogen free extract, %	32.35	39.74	48.60	45.43	39.41	41.87	39.43	38.44
5. Minerals,%	9.60	7.27	9.10	6.72	8.01	7.40	6.24	6.08
6. Nutritive units, NU/kg	0.77	0.89	0.72	0.83	0.80	0.85	0.84	0.60
7. Metabolizable energy, MJ/kg	7.89	9.90	8.85	8.84	8.65	9.44	10.44	8.05
8. Calcium, g/kg s.a.u.	6.37	12.89	14.00	12.08	16.83	14.60	11.16	13.61
9. Phosphorus, g/ kg s.a.u.	4.52	5.66	2.19	1.00	4.39	5.33	7.52	2.51
10. Digestible protein, g/nutritive unit	225.09	132.10	106.28	135.30	164.29	154.13	156.00	144.80

The vegetable fats in forage are the main source of energy for the animals because they are necessary for the organism in order to ensure the normal development of vital processes and transportation of soluble vitamins in fatty acids and it also contributes to the accumulation of fat in milk [McDONALD & al. 2011]. The forage of *Lotus corniculatus* and *Onobrychis arenaria* contains a high amount of fats (3.20-3.55%), at the same level as *Onobrychis viciifolia*, greatly exceeding *Medicago sativa.* The *Medicago falcata* has a low content of fats -1.78% (Tab. 3, line 2, column 4, 5, 6, 7, 8).

The content of cellulose is quite low in the species *Lotus corniculatus*, *Onobrychis arenaria*, *Medicago falcata* and very high in *Trifolium repens* (Tab. 3, line 3, column 4, 5, 7, 9). We also mention that the optimal cellulose content has a beneficial effect on the synthesis of proteic substances in the rumen of animals and on the reduction of the nitrate content [BAHCIVANJI & al. 2012].

The nitrogen-free extract (NFE), along with fats, provides the necessary energetic material for vital processes, contributing to the formation and storage of fats [PÂRVU 1992; BAHCIVANJI & al. 2012]. The content of nitrogen-free extract varies from 32.35% to 48.60%, it is high in the species *Lotus corniculatus*, *Onobrychis arenaria*, *Medicago falcata* and very low in *Astragalus ponticus*, this fact influences the possibility of the forage to provide energy (Tab. 3, line 4, column 2, 4, 5, 6).

The vegetal forage contains minerals in variable quantities, regarding the type of the elements and the proportion between them and other chemical compounds. Minerals are essential components of all tissues and organs that maintain a constant osmotic pressure, participate in the regulation of acid-base balance, activate a number of enzymes, moderate neuromuscular activities and prevent the emergence and development of diseases in animals. The presence of minerals in animal feed is indispensable for their growth and health

[SUTTLE, 1982]. The forage of *Lotus corniculatus* and *Astragalus ponticus* is characterized by a high content of minerals (9.10-9.60%), but the forage of *Trifolium repens* – by a lower one (6.08%), in comparison with the control species (Tab. 3, line 5, column 2, 4, 9).

Calcium is the mineral element that is found in the highest quantity in the animal body, it is a structural component of bones and teeth; it plays an essential role in blood coagulation, tensing of muscles, activity of enzyme systems, at cell level. The normal assimilation of calcium by organism depends also on the quantity of phosphorus in the feed. Phosphorus plays a multiple role in the vital processes in body, and, being a constituent of nucleic acids, it participates in protein synthesis, cell multiplication and transmission of hereditary characters; it is a component of ATP (adenosine triphosphate) the main deposit of energy in tensing of muscles, nerve activity, vital processes of body; as phospholipids, it enters the structure of cells and cell membranes regulating the transportation of solutions through them; participates in the metabolization of carbohydrates, fatty acids and amino acids etc. [SUTTLE, 1982; McDONALD & al. 2011].

The content of calcium in the studied species varies from 6.37 g/kg (*Astragalus ponticus*) to 14.60 g/kg (*Onobrychis arenaria*), being lower than in *Medicago sativa* (16.83 g/kg). Very low content of calcium has been found in the forage of *Astragalus ponticus* (6.37 g/kg), the other species (*Coronila varia*, *Lotus corniculatus*, *Medicago falcata*, *Medicago sativa*, *Onobrichys arenaria*, *Trifolium repens*) have higher levels of calcium (12.08-16.83 g/kg) than *Onobrychis viciifolia* – 11.16 g/kg (Tab. 3, line 8, column 1, 6, 8). The studied species have lower content of phosphorous (1.00-5.56 g/kg) than *Onobrychis viciifolia* (7.52 g/kg). The species *Medicago falcata*, *Lotus corniculatus* and *Trifolium repens* have very low content of phosphorous (corresponding 1.0, 2.19 and 2.51 g/kg). The species *Coronilla varia* and *Onobrychis arenaria* are distinguished by high content of phosphorous (corresponding 5.66 and 7.52 g/kg) as compared with *Medicago sativa* – 4.39 g/kg (Tab. 3, line 9, column 1, 6, 7).

The main indicators of the nutritional value of the natural forage are the content of nutritive units and metabolizable energy (MJ). The nutritional and energy value is determined by the biochemical composition and the digestibility of the organic substances from the forage that influence the health and the productivity of animals [MEDVEDEV & SMETANNIKOVA, 1981; McDONALD & al. 2011]. The nutritive units (NU) of the natural forage of the studied species reaches amounts of 0.60 (*Trifolium repens*) up to 0.89 NU/kg (*Coronilla varia*). *Trifolium repens* and *Lotus corniculatus* species containing 0.20 and 0.08 NU/kg correspondingly less than the control *Medicago sativa*. At the level control (0.80 NU/kg) are species *Astragalus ponticus* (0.77), *Medicago falcata* (0.83), *Onobrychis arenaria* (0.85) and *Onobrychis viciifolia* (0.84 NU/ kg). According to this index, species *Coronilla varia* is the most valuable forage crop (0.89 NU/kg).

Metabolizable energy is an index assessing the capacity of the feed to support of the processes of the milk production. This indicator of the studied species ranges from 7.89 up to 10.44 MJ/kg dry matter. The energy value of the forage of *Coronilla varia* and *Onobrychis arenaria* is at the same level as *Onobrychis viciifolia* (corresponding 9.90, 9.44 and 10.44 MJ/kg). The value of the metabolize energy of *Trifolium repens* (8.05), *Lotus corniculatus* (8.85) and *Astragalus ponticus* (7.89) is same in comparison with *Medicago sativa* (8.65 NJ/kg) - Tab. 3, row 7, columns 2, 4, 6, 9.

An important indicator of forage value is the content of digestible protein per nutritive unit. The content of digestible protein (DP) per nutritive unit (NU) ranges from 106.28 g DP/NU (*Lotus corniculatus*) up to 225.09 g DP/NU (*Astragalus ponticus*) and meets the zootechnical standards. Also green fodder of *Onobrychis viciifolia*, *Onobrychis arenaria* and *Trifolium repens* have high level of digestible protein (Tab. 3).

The amino acid composition is the most important factor in defining the food protein quality, followed by the digestibility of the protein and the bioavailability of its amino acids. The protein quality is determined by the ratio of certain amino acids, which provide the biological value of the feed. The efficiency of using protein crops in animal feed production strongly depends on the content of essential amino acids (EAA) in the various crops and the composition of compound feedstuffs [PÂRVU, 1992; McDONALD & al. 2011]. An essential amino acid, or indispensable amino acid, is an amino acid that cannot be synthesized de novo (from scratch) by the organism, and thus must be supplied in its diet. The nine amino acids humans cannot synthesize are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine, and histidine [McDOUGALL, 2002].

By analysing the amino acid content, we have found that the forage obtained from the studied species contains different amounts of amino acids, including those essential. The total amount of amino acids ranging from 8.316 mg/100 mg (*Lotus corniculatus*) to 13.377 mg/100 mg (*Astragalus ponticus*). The species *Onobrychis arenaria* and *Astragalus ponticus* contain the highest amount of essential amino acids, but *Lotus corniculatus*, *Medicago falcata* and *Coronilla varia* contain a very low amount. It has been found that all the studied species have a lower content of methionine than *Medicago sativa*, but the species *Onobrychis arenaria*, *Coronilla varia* and *Lotus corniculatus* are distinguished by a higher content of methionine in comparison with *Onobrychis viciifolia* (Tab. 4).

Tab. 4. The content of amino acids in forage (mg/100 mg dry matter) of the studied species of the family *Fabaceae*

Amino acids	*Astragalus ponticus*	*Coronilla varia*	*Lotus corniculatus*	*Medicago falcata*	*Medicago sativa*	*Onobrychis arenaria*	*Onobrychis viciifolia*	*Trifolium repens*
1	2	3	4	5	6	7	8	9
1. asparagine	3.110	1.857	1.129	1.871	1.711	2.037	1.751	1.593
2. **threonine***	**0.678**	**0.551**	**0.633**	**0.611**	**0.564**	**0.624**	**0.565**	**0.559**
3. serine	0.767	0.678	0.767	0.810	0.687	0.747	0.685	0.663
4. glutamine	1.953	1.418	0.941	1.659	1.360	1.561	1.398	1.381
5. proline	0.765	1.480	0.355	0.767	0.922	1.063	1.154	1.062
6. glycine	0.676	0.852	0.477	0.470	0.550	0.638	0.557	0.613
7. alanine	0.570	0.712	0.607	0.750	0.674	0.687	0.672	0.665
8. **valine**	**0.649**	**0.459**	**0.369**	**0.193**	**0.559**	**0.703**	**0.654**	**0.621**
9**. methionine**	**0.058**	**0.101**	**0.117**	**0.073**	**0.139**	**0.098**	**0.091**	**0.052**
10. isoleucine	0.510	0.344	0.315	0.422	0.459	0.502	0.459	0.453
11**. leucine**	**0.914**	**0.898**	**0.816**	**0.704**	**0.913**	**1.014**	**0.920**	**0.929**
12. tyrosine	0.458	0.442	0.319	0.427	0.458	0.543	0.491	0.517
13**. phenylalanine**	**0.794**	**0.647**	**0.416**	**0.510**	**0.850**	**1.035**	**0.937**	**0.806**
14. **histidine**	**0.411**	**0.239**	**0.136**	**0.295**	**0.326**	**0.406**	**0.371**	**0.364**
15**. lysine**	**0.760**	**0.524**	**0.517**	**0.673**	**0.619**	**0.746**	**0.706**	**0.658**
16. arginine	0.306	0.517	0.402	0.577	0.655	0.564	0.587	0.584
17. *Total sum of AA*	*13.377*	*11.719*	*8.316*	*10.812*	*11.456*	*12.968*	*11.998*	*11.520*
18. *Total sum of EAA*	**4.264**	**3.419**	**3.004**	**3.059**	**3.970**	**4.626**	**4.244**	**3.989**

* - essential amino acids are in bold

The species *Astragalus ponticus* and *Onobrychis arenaria* contain a higher amount of lysine (0.746-0.760 mg/100 mg) than the traditional crops, but the species *Coronilla varia* and *Lotus corniculatus* – a lower one (0.517-0.524 mg/100 mg). In comparison with traditional forage crops, *Astragalus ponticus* is characterized by a higher content of threonine, glutamine, valine, isoleucine and histidine; *Coronilla varia* is very rich in proline and glycine, rich in asparagine, glutamine, glycine and alanine; *Lotus corniculatus* – rich in threonine and serine,

Medicago falcata – rich in asparagine, threonine, serine, glutamine and alanine. *Trifolium repens*, as compared with *Medicago sativa*, is richer in proline, glycine, valine, leucine, tyrosine, histidine and lysine. The content of essential amino acids varies from 3.004 mg/100 mg (*Lotus corniculatus*) up to 4.626 mg/kg (*Onobrychis arenaria*); *Medicago sativa* – 3.970 mg/100 mg (Tab. 4).

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 inorganic N fertilizer in conventional farms, if the digestate is applied as a fertilizer to the non-legume crops [STODDARD, 2013]. The content of organic matter, biochemical composition, biodegradability and ratio of carbon and nitrogen (C/N) of the raw material are essential in the production of biogas. The C/N ratio of the studied species varied from 13, in the biomass of *Astragalus ponticus*, to 29-30, in the biomass of *Trifolium repens* and *Lotus corniculatus* (Tab. 5). The optimal C/N ratio is expected to be in the range 15-25, when the anaerobic digestion process is carried out in a single stage, and for the situation when the process develops in two steps, the optimal C/N ratio will range: for step I: 10-45; for step II: 20-30 [DOBRE & al. 2014].

Fermentable organic matter represents the proportion of organic matter which can be biologically degraded under anaerobic conditions and, thus, can be potentially utilized in biogas facilities [WEISSBACH, 2008]. The calculated gas forming potential of the fermentable organic matter of the studied *Fabaceae* species varied from 470 to 544 litre/kg volatile solid matter (VS), *Trifolium repens*, *Coronilla varia* – lower than *Medicago sativa*, but *Onobrychis arenaria*, *Medicago falcata* and *Lotus corniculatus* – exceeding *Onobrychis viciifolia*, they have similar content of methane. The methane yield per ha of studied species of the family *Fabaceae* (first mowing) ranged from 692 to 3197 m^3/ha, *Onobrychis arenaria* exceeding *Onobrychis viciifolia*, but *Coronilla varia* exceeding *Medicago sativa*.

Tab. 5. Gas forming potential of the fermentable organic matter (FOM) from the studied *Fabaceae* species

Indicators	***Astragalus ponticus***	***Coronilla varia***	***Lotus corniculatus***	***Medicago falcata***	***Medicago sativa***	***Onobrychis arenaria***	***Onobrychis viciifolia***	***Trifolium repens***
1	2	3	4	5	6	7	8	9
1. Ratio carbon/nitrogen	13	22	30	22	19	18	19	29
2. FOM, g/kg VS	641	626	680	678	642	685	658	588
3. Biogas, litre/kg VS	513	501	544	542	514	542	526	470
4. Methane, litre/kg VS	269	263	286	285	270	288	276	247
5. Methane yield, m^3/ha	1076	2311	1571	1881	2214	3197	2843	692

Conclusions

The species *Coronilla varia* and *Lotus corniculatus* can be harvested, for the first time, 5 days earlier, but *Medicago falcata* and *Onobrychis viciifolia* – 18 days later than *Medicago sativa*. Due to this fact, fresh natural forage can be provided for animals for a longer period of time.

The green mass yield varied from 0.83 kg/m^2 to 4.08 kg/m^2. The species *Onobrychis arenaria* and *Coronilla varia* have a productivity of 3.92-4.08 kg/m^2 green mass, at the same level as *Onobrychis viciifolia*, but by 26-31% higher than *Medicago sativa*.

The natural forage of the studied species reaches amounts of 0.60-0.89 nutritive units and 8.05-9.90 MJ/kg dry matter. The methionine content in the species *Onobrychis arenaria*,

Coronilla varia and *Lotus corniculatus* reaches 0.098-0.117 mg/100 mg of dry matter, thus, it is higher than in *Onobrychis viciifolia*, but lower as compared with *Medicago sativa*.

The calculated methane yield from the green mass of *Onobrychis arenaria* and *Coronilla varia* at the first harvest may reach 2311-3197 m^3/ha, exceeding *Medicago sativa*.

The studied taxa can serve as starting material in improving and implementing new varieties leguminous species in the production of protein rich forage, as well feedstock for biogas production.

References

ACAR Z., AYAN I. & GULSER C. 2001. Some morphological and nutritional properties of legumes under natural conditions. *Pakistan Journal of Biological Sciences*. **4**(11): 1312-1315.

BADGER C. M., BOGUE M. J. & STEWART D. J. 1979. Biogas production from crops and organic wastes. *New Zeland Journal of Science*. **22**: 11-20.

BAHCIVANJI M., COȘMAN S., CARAUȘ S. & COȘMAN V. 2012. *Caracteristica şi valorificarea raţională a plantelor furajere naturale şi cultivate*. Chișinău: Edit. Știința, 378 pp.

DAVIS A. M. 1982. Nitrogen production by selected *Astragalus* species. *Agronomy Journal*. **74**(3): 454-456.

DOBRE P., FARCAȘ N. & MATEI F. 2014. Main factors affecting biogas production – an overview. *Romanian Biotechnological Letters*. **19**(3): 9283-9286.

DRONOVA T. N., BURTSEVA N. I., NEVEZHIN S. Y., BOLDYREV V. V.& MOLOKANTSEVA E. I. 2009. Nontraditional perennial legumes herbs under irrigation. *Proceedings of Nizhnevolzhskiy agrouniversity complex*. **1**(13): 40-48 [in Russian].

DUKE J. A. 1981. Handbook of legumes of world economic importance. New York and London: Edit. Plenum Press, 345 pp.

MARUȘCA M., TOD M., SILISTRU D., DRAGOMIR N. & SCHITEA M. 2011. *Principalele soiuri de graminee şi leguminoase perene de pajişti.* Braşov. http://pajisti-grassland.ro/proiecte/lucrari/soiuri.pdf

McDONALD P., EDWARDS R. A., GREENHALGH J. F. D., MORGAN C. A., SINCLAIR L. A. & WILKINSON R. G. 2011. *Animal nutrition*. 7th ed. Harlow: Edit. Pearson Education, 694 pp.

McDOUGALL J. 2002. Plant foods have a complete amino acid composition. *Circulation*. **105**(25): e197.

MEDVEDEV P. F. & SMETANNIKOVA A. I. 1981. *The forage crops of European part of the USSR*. Leningrad: Edit. Kolos, 336 pp. [in Russian].

NEGRU A. 2007. *Determinator de plante din flora Republicii Moldova*. Chișinău: Edit. Universul, 391 pp.

NOVOSELOV Y. K., KHARKOV G. D. & SHEKHOVTSOVA N. S. 1983. *Methodical instructions for conducting field experiments with forage crops*. Moscow: Edit.VNNIK 197 pp. [in Russian].

PÂRVU G. 1992. *Supravegherea nutriţional metabolică a animalelor*. București: Edit. Ceres. 392 pp.

PETUKHOV E. A., BESSARABOVA R. F., HOLENEVA L. D. & ANTONOVA O. A. 1989. *Zoo technical analysis of the feed*. Moscow: Edit. Agropromizdat, 239 pp. [in Russian].

STODDARD F. L. 2013. *Novel feed and non-food uses of legumes*. Legume Futures Report 1.3. www.legumefutures.de

SUTTLE N. F. 2010. *Mineral nutrition of livestock*. 4th Revised edition. Cambridge: CABI Publishing, 587 pp. http://dx.doi.org/10.1079/9781845934729.0000.

TELEUTĂ A. 2010. Introducerea și studierea plantelor furajere netradiționale: realizări și perspective. *In. Conservarea diversităţii plantelor*. Chișinău: Edit. Știința: 425- 432.

TELEUȚĂ A. & ȚÎȚEI V. 2012. Non-traditional plants of the legume family: their feeding value and productivity under the conditions of the Republic of Moldova. *Tavricheskii naukovii visnic*. **80**(2): 338-342 [in Russian].

TELEUȚĂ A. & ȚÎȚEI V. 2016. Mobilization, acclimatization and use of fodder and energy crops. *Journal of Botany*. **1**(12): 112-120.

WEISSBACH F. 2008. On assessing the gas production potential of renewable primary products. *Landtechnik*. **6**: 356-358.

How to cite this article:

TELEUȚĂ A. & ȚÎȚEI V. 2016. Economic value of some leguminous plant species of the collections from the Botanical Garden (Institute) of the Academy of Sciences of Moldova. *J. Plant Develop*. **23**: 27-35.

***Received*: 31 October 2016 / *Revised*: 3 December 2016 / *Accepted*: 6 December 2016**