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AGROBIOLOGICAL PECULIARITIES AND PROSPECTS OF THE *Lathyrus perennial* SPECIES IN MOLDOVA

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Abstract

We investigated the agrobiological peculiarities and biochemical composition of the species Lathyrus latifolius, Lathyrus pisiformis and Lathyrus sylvestris from the Botanical Garden (Institute) of the Academy of Sciences of Moldova, the traditional leguminous fodder crops Medicago sativa and Onobrychis viciifolia served as control variants. The fodder productivity of Lathyrus sylvestris reached 10534 nutritive units/ha and 2085 kg/ha of digestible protein; Lathyrus latifolius – 9891 nutritive units/ha and 2085 kg/ha of digestible protein; exceeding essentially the traditional leguminous fodder crops Medicago sativa and Onobrychis viciifolia. Lathyrus latifolius was distinguished by high levels of phosphorus, potassium, magnesium, iron, copper and manganese, but reduced levels of calcium and strontium in fodder. The methane yield of Lathyrus species ranged from 1821 to 2936 m^3/ha. The more promising species as feedstock for biogas production, Lathyrus sylvestris and Lathyrus latifolius exceeded Medicago sativa with 33 %.

Key words: *agro biological peculiarities, biochemical composition, biogas yield, fodder value, Lathyrus species.*

INTRODUCTION

Agriculture plays an important role in the world economy since it provides much of the food that is necessary for people as well as raw material for various industrial sectors. Livestock production is an important source of protein and other nutrients for human diet, and the development depends on the production of fodder which is necessary for animal nutrition. A higher fodder production can be achieved by increasing the diversity of cultivated species, by expanding the areas where fodder crops are grown and by creating new varieties with increased genetic potential for productivity, quality and increased resistance to harmful biotic and abiotic factors.

In the Botanical Garden (Institute) of the ASM, it has been founded the fodder plant collection, which currently includes more than 320 taxa from different floristic regions (Europe, Asia and America). Particular attention is paid to mobilization and study of species of the family *Fabaceae* Lindl., which can contribute to the production of nutritionally balanced forage, while providing a part of the protein, carbohydrate and mineral requirements (Teleuță and Titei, 2012; 2014).

One important advantage of legume crop production is the ability of these species to form symbiotic associations with nitrogen (N)-fixing *Rhizobium* bacteria, reducing their dependence on inorganic N fertilizers, nutrient recycling, soil structural benefits, erosion control and nitrogen nutrition for following crops (Duke, 1981; Luscher et al., 2003). The fodder leguminous species play an important role in increasing the quality of feed, due to a significant contribution in protein, vitamins and minerals, which raise the nutritional value of feed and livestock products, they are also used as raw material for anaerobic digestion, produce biogas, a methane-rich gas that can be used as fuel and digestate, a source of nutrients. However, if digestate is used for manuring, nutrients will be kept in the biological cycle – which saves emissions from an energy-intensive mineral fertiliser production (Montemurro et al., 2003).

The genus *Lathyrus* L. is the largest genus in the economically important tribe *Fabeae* (Adans.) DC., family *Fabaceae* Lindl. Most researchers divide *Lathyrus* into 12 or 13 sections which include about 160 species. It is distributed throughout temperate regions of the northern hemisphere and extends into tropical East Africa and South America. Its main

centres of diversity are in the Mediterranean and Irano-Turanian regions, with smaller centres in North and South America. Most *Lathyrus* species are diploid ($2n = 14$), with a few natural autopolyploids or allopolyploids, or contain both diploid and autopolyploid forms. Members of the *Lathyrus* genus include food and fodder crops, ornamental plants, are used in medicine, as soil nitrifiers, dune stabilizers, important agricultural crops and model organisms for genetic and ecological research (Belaid et al., 2006; Chtourou-Ghorbel et al., 2001). *Lathyrus sylvestris* is the most studied of the perennial species of this genus (Flachowsky et al., 1982; Foster, 1990; Kuporitskaia, 1978; Pavelka, 1985; Kupicha 1983).

Lathyrus latifolius L., synonyms *Lathyrus megalanthus* Steud., common names: Everlasting peavine, Everlasting-pea, Perennial pea, Perennial sweet pea, Broad-leaved Everlasting Pea. Romanian: Mănerei de pădure. It is a perennial plant, 1-2 m tall, with prostrate or climbing stem, clutching by means of leaf tendrils. Its stem is biangular, with two broad wings. Stipules – broadly lanceolate, semisagittate, 2-4 cm long, about 1 cm wide, with well distinct longitudinal veins. Petioles – broadly winged. Leaf rachis ends in a branched tendril. Leaves consist of 1 pair of oblong-oval leaflets, 5.5-9 cm long, 1-3(5) cm wide, with 3-5 very distinct veins. Leaf blade ends in a cusp. Peduncles are thick, angular and longer than leaves. Inflorescence is a rather lax raceme of 3-10 flowers. Pedicel is as long as calyx. Flowers are large, 2-2.5 cm long, bright red. Calyx is broadly campanulate, its upper teeth are triangular-lanceolate, as long as tube, lower tooth lanceolate-subulate, longer than tube and the other calyx teeth. Standard gradually narrowed toward its base into short unguis, wings distinctly shorter than standard, on narrow short unguis, keel half-round, on short unguis. Pods are oblong-linear, horizontally patent, narrower toward base, 5-6 cm long, about 1 cm wide, compressed, with acuminate end, with 3 longitudinal scabrous ribs at upper suture. Pod valves with longitudinal-reticular venation. Seeds are globose or oblong, weakly tuberculate. General distribution: Central and Atlantic Europe, Mediterranean. Former USSR: European part - Carpathians, Moldova, Dnieper area, Crimea (Smekalova, 2008a).

Lathyrus pisiformis L. common names: Pisiform grass pea. Perennial plant, 50-100 cm in height, with a long, branchy root. Stems slightly cling with the help of short cirri; stems are almost upright. Stipules are large, 20-50 mm in length, 8-18 mm in width, ovate, with lengthened top and denticles at the base. Leaves are bluish green below, usually consisting of 4-6 pairs of ovate or oval leaflets, 25-50 mm in length and 10-30 mm in width. The leaf axis culminates in short cirrus. Racemes are shorter than leaves, with 8-15 flowers. Flowers are medium-sized, 10-15 mm in length, red-lilac. Pedicels are shorter than the calyx. Calyx is short and tubular, thickening slightly at the base; its denticles are triangular. Flag is round-elliptical with dark mesh veins and dredging on top, on wide stem. Wings are oblong-lanceolate. Keel is bent almost at a right angle to the bottom edge. Pods are linear, slightly compressed from the sides, 40-50 mm in length, 4-5 mm in width. Valves of pods are dark brown. Seeds are almost spherical, brown; there are 10-12 seeds in a pod. Hilum length is equal to 1/6 the circumference of the seed. Chromosome number: 2n=14. Distribution: Central Europe, Russia (Smekalova, 2008b).

This research was aimed to evaluate the biological peculiarities, biochemical composition of the natural fodder of the perennial species of the genus *Lathyrus* L. (*L. latifolius, L. pisiformis, L. sylvestris)* in the conditions of Moldova and perspectives for their use as fodder in animal husbandry and as biogas substrate.

MATERIALS AND METHODS

The perennial species of the genus *Lathyrus*: *Lathyrus latifolius, Lathyrus pisiformis, Lathyrus sylvestris* maintained in monoculture, served as object of study. The traditional leguminous fodder crops *Medicago sativa* and *Onobrychis viciifolia* served as control variants. The experiments were performed on non irrigated experimental land in the Botanical Garden (Institute) of the ASM with previously scarified seeds of *Lathyrus* species. They started in spring, when the soil had reached the physical readiness. The experimental design was a randomised complete block design with four replications, and the experimental plots measured 10 m^2.

The seeds were sown at a depth of 2.0-3.0 cm with soil compaction before and after sowing. The scientific researches on growth and development, yield and biochemical composition of the plants were carried out according to the methodical indications (Novosiolov et al.,, 1983; Petukhov et al., 1989).

The carbon content of the substrates was obtained from volatile solids (organic dry matter) data using an empirical equation reported by Badger et al. (1979).

The biogas production potential and the specific methane yields were evaluated by the parameter "content of fermentable organic matter", according to Weissbach (2008).

RESULTS AND DISCUSSIONS

As a result of the conducted research, it has been established that the studied *Lathyrus* species need a moist seedbed for seed germination. In spite of the fact that seeds had been previously scarified mechanically, the emergence of seedlings at the soil surface was uneven and occurred 15-27 days later in comparison with traditional leguminous fodder crops. In the first year of vegetation, the studied species had a rather slow growth and development rate. Thus, *Lathyrus latifolius* and *Lathyrus sylvestris* plants reached the flowering stage and grew 43-54 cm tall, and *Lathyrus pisiformis* developed a rosette which grew up to 23 cm tall.

We might mention that, the next year, the vegetation period of the species of the genus *Lathyrus* started 3-7 days later in comparison with *Medicago sativa* and *Onobrychis viciifolia*, the most delayed start of vegetation period was characteristic of the species *Lathyrus latifolius*. In comparison with traditional leguminous fodder crops, the *Lathyrus* species needed a 17-33 day longer period to reach budding period, a 8-50 day longer period – to reach flowering stage and a 30-51 day longer period – to reach seed maturation. A more delayed development during the growing season was characteristic of *Lathyrus sylvestris* plants; we could also mention that *Lathyrus latifolius* plants had a more rapid pace of development and were distinguished by a short flowering period (Table 1).

From the resumption of growth till the end of April, a more rapid growth rate was observed in *Lathyrus sylvestris* plants (26.4 cm) and a slower one – in *Lathyrus pisiformis* plants (19.6 cm), this tendency was maintained in the flowering phase. During this period, *Lathyrus sylvestris* plants reached 187.78 cm, *Lathyrus latifolius* – 165.60 cm and *Lathyrus pisiformis* – 124.40 cm while the control *Medicago sativa* and *Onobrychis viciifolia* plants reached 83.20-85.50 cm high. In other studies, it has been mentioned that *Lathyrus sylvestris* plants can reach 3.00 m (Kuporitskaia, 1978), *Lathyrus pisiformis* – 0.75 m (Abramciuc, 2013).

The total forage yield, the quality and the seasonal distribution of forage production may be of great importance to the livestock producers.

It is known that about 65-80% of the yield is obtained at the first harvest. We might mention that, in the second year, *Lathyrus sylvestris* and *Lathyrus latifolius* provided a natural fodder yield of 4.58-4.71 kg/m^2 or 1.03-1.16 kg/m^2 dry matter, exceeding *Medicago sativa* with 25-40 % and *Onobrychis viciifolia* with 16-18 %. *Lathyrus pisiformis* plants provided a poorer yield; this can be explained by the fact that this species, as claimed by some authors (Vishnjakova and Belyaeva, 2006; Povalyaeva, 1992) achieves full yield potential in the 4th vegetation year.

The harvested fodder of the studied *Lathyrus* species was richer in leaves (48-55%).

In some papers, it has been mentioned that the fresh mass of *Lathyrus sylvestris* harvested in the 4th vegetation year reaches 92-125 t/ha (Foster, 1990; Kuporitskaia, 1978), *Lathyrus latifolius* – 95.5 t/ha (Aleman and Wotto, 2003).

Proteins have high biological value for growth and serve as structural elements in all plant tissues. In the animal body, they are utilized for growth, replacement of old, damaged or worn-out cells/tissues and formation of milk. They are of particularly great value to young growing animals and lactating ruminants (McDonald et. al., 2010). It has been found that the studied species of the genus *Lathyrus* are characterized by relatively high content of protein in dry matter, ranging from 20.31% at *Lathyrus pisiformis* to 22.62% at *Lathyrus latifolius*.

Table 1. Agro-biological peculiarities of the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Days from the beginning of vegetation up to:					
- budding	75	103	92	103	70
- flowering	99	132	107	128	82
- seed ripening	133	184	165	163	143
Plant height, cm					
- at the end of April	23.30	26.40	22.00	19.60	38.10
- at flowering	85.50	187.78	165.60	124.40	83.20
The yield:					
- fresh mass, kg/m^2	3.95	4.58	4.71	2.33	3.11
- dry matter, kg/m^2	1.03	1.16	1.03	0.63	0.82
The leaf share of the fodder, %	35	54	55	48	35

Table 2. Fodder value of the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Nutritive units	9085	10534	9891	6291	6531
Metabolizable energy for cattle, GJ/ha	113	114	106	54	71
Digestible protein productivity, kg/ha	1471	2085	1887	1038	1073
Digestible protein, g/ nutritive unit	160	198	190	166	164

The studied *Lathyrus* species are characterised by lower fat content (2.50-3.06%) in comparison with *Onobrychis viciifolia,* but advanced – in comparison with *Medicago sativa.* Analyzing each species, we could mention that *Lathyrus sylvestris* has high content of cellulose and minerals and low content of fat and nitrogen free extractive substances, and *Lathyrus latifolius* and *Lathyrus pisiformis* – inversely proportional. The dry matter content and its biochemical composition influence the nutritional value of fodder. It has been found that the harvested fodder of *Lathyrus pisiformis* has high dry matter content, but not as high as *Onobrychis viciifolia*.

We might also mention that the harvested fodder of the studied species of the genus *Lathyrus* has higher content of digestible protein: 40-45 g/kg natural fodder or 166-197 g/ nutritive unit.

In the conditions of the Republic of Moldova, the fodder productivity of *Lathyrus sylvestris* reaches 10534 nutritive units/ha, 2085 kg/ha of digestible protein and 114 GJ/ha metabolizable energy for cattle; *Lathyrus latifolius* – 9891 nutritive units/ha, 2085 kg/ha of digestible protein and 106 GJ/ha metabolizable energy for cattle; exceeding essentially the traditional leguminous fodder crops *Medicago sativa* and *Onobrychis viciifolia* (Table 2).

The species *Lathyrus latifolius* and *Lathyrus pisiformis* have about the same carotene content (30 mg/kg) in the fodder as *Onobrychis viciifolia*, but a higher content in comparison with *Medicago sativa.* The fodder of *Lathyrus sylvestris* is very poor in carotene (10 mg/kg). Vitamin C plays an important role in the body due to its strong antioxidant character. The fodder of *Lathyrus latifolius* contains 19.96 mg/%, *Lathyrus sylvestris* – 35.71 mg/% and *Lathyrus pisiformis* – 39.73 mg/% versus 41.21 mg/% in *Onobrychis viciifolia* and 45.23 mg/% – *Medicago sativa.*

The presence of minerals in animal nutrition is indispensable for their growth and health, because they are essential components of all tissues and organs that maintain osmotic pressure at a constant level, participate in the regulation of acid-base balance, activate a number of enzymes, moderate the neuromuscular activity and prevent the emergence and development of diseases of animals (McDonald et. al., 2010).

The content of mineral elements in fodder is variable, depending on species. It has been established that the content of macro elements in the dry matter of the harvested fodder of the studied *Lathyrus* species is as follows: 6.76-12.05 g/kg of calcium, 5.54-10.00 g/kg of phosphorus, 9.33-18.86 g/kg of potassium, and 2.89-4.58 g/kg of magnesium (Table 3).

Comparing each macro element separately, we could mention that the content varies from species to species. The species *Lathyrus sylvestris* and *Lathyrus pisiformis* are characterised by higher content of phosphorus and magnesium in comparison with *Medicago sativa,* but lower – in comparison with *Onobrychis viciifolia; Lathyrus latifolius* has high content of phosphorus, potassium, magnesium and reduced – of calcium.

Sodium is the chief cation of blood plasma and other extracellular fluids of the body; it plays an important role in the transmission of nerve impulses and in the absorption of sugars and amino acids from the digestive tract. The *Lathyrus* species have about the same sodium content as *Onobrychis viciifolia*, but advanced – in comparison with *Medicago sativa.*

It has been determined the content of trace elements in the dry matter of *Lathyrus* species which constitutes: 4.53-10.33 mg/kg copper, 22.13-27.38 mg/kg zinc, 68.19-113.93 mg/kg manganese, 194.75-381.73 mg/kg iron, and 28.41-45.32mg/kg strontium. The fodder of *Lathyrus latifolius* contains high amounts of iron, copper and manganese; *Lathyrus sylvestris* is poor in iron, zinc, strontium and manganese; *Lathyrus pisiformis* is poor in zinc and copper, but contains large amounts of strontium.

The high content of protein would influence positively the methane production.

The ratio of the content of carbon and nitrogen (C/N) of the raw material is essential in the production of biogas. The C/N ratio of the studied *Lathyrus* species varied from 14 to 16, *Medicago sativa* and *Onobrychis viciifolia* – 19 (Table 4). 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 et al., 2014).

The gas forming potential of the fermentable organic matter of biomass of the studied *Lathyrus* species varied from 448 to 550 litre/kg VS (Table 4). The best methane yield was achieved in *Lathyrus latifolius* and *Lathyrus pisiformis* with methane production yield of 285-289 l litre/kg VS, the lowest – in the biomass of *Lathyrus sylvestris.*

The methane yield per ha of studied species of the family *Fabaceae* ranged from 1821 to 2936 m^3/ha, *Lathyrus sylvestris* and *Lathyrus latifolius* exceeding *Medicago sativa* with 33 %.

Table 3. Chemical composition of the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Minerals, per kg dry matter					
Calcium, g	11.20	6.76	9.84	12.05	16.94
Phosphorus, g	7.53	7.18	10.10	5.54	4.42
Magnesium, g	3.28	2.89	4.58	3.27	2.71
Potassium, g	15.17	10.33	18.86	9.33	15.38
Sodium, mg	366.20	387.40	361.76	373.20	349.50
Iron, mg	343.20	194.75	381.73	209.83	250.83
Manganese, mg	91.55	68.19	113.93	85.86	50.90
Zink, mg	26.15	24.00	27.38	22.13	22.37
Copper, mg	6.75	6.97	10.33	4.53	7.00
Strontium, mg	34.53	28.41	28.42	45.32	49.77

Table 4. Gas forming potential of the fermentable organic matter from the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Ratio of content carbon and nitrogen (C/N)	19	14	14	16	19
Fermentable organic matter, g/kg VS	658	603	678	687	642
Biogas, liter /kg VS	526	448	543	550	514
Methane, liter /kg VS	276	253	285	289	270
Methane productivity, m3/ha	2843	2935	2936	1821	2214

CONCLUSIONS

1. In the conditions of the Republic of Moldova, the fodder productivity of *Lathyrus sylvestris* reaches 10534 nutritive units/ha and 2085 kg/ha of digestible protein; *Lathyrus latifolius* – 9891 nutritive units/ha and 2085 kg/ha of digestible protein; exceeding essentially the traditional leguminous fodder crops *Medicago sativa* and *Onobrychis viciifolia*.
2. The species *Lathyrus pisiformis* has about the same digestible protein productivity as *Medicago sativa.*
3. *Lathyrus latifolius* is distinguished by a high level of phosphorus, potassium, magnesium, iron, copper and manganese, but a low one of calcium and strontium in fodder.
4. The methane yield per ha ranged from 1821 to 2936 m^3/ha, *Lathyrus sylvestris* and *Lathyrus latifolius* exceeding *Medicago sativa* with 33 %.

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