PRODUCTIVITY AND NUTRITIONAL VALUE OF SOME LEGUMINOUS FORAGE SPECIES IN THE REPUBLIC OF MOLDOVA

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Abstract. *We have studied the biological peculiarities, productivity, nutritional value of the species Medicago falcata L., Medicago varia Mart., Medicago tianschanica Vass., Medicago borealis Grossh., Medicago hemicycla Grossh., Medicago polychroa Grossh., Medicago difalcata Sinsk., Onobrychis arenaria (Kit.) DC, Onobrychis inermis Steven, which were cultivated in the collection of non-traditional forage plants of the Botanical Garden (Institute) of the ASM. Traditional fodder leguminous crops, alfalfa Medicago sativa L. and sainfoin Onobrychis viciifolia Scop., were used as control variant. The species Medicago tianschanica, Medicago varia and Medicago polychroa have a productivity of 1.79-2.14 kg/m^2 natural forage surpassing by 9-27% Medicago sativa, with a nutritive value of 0.20-0.25 nutritive units/kg and a digestible protein content of 196.2-211.6 g/nutritive unit. The species Onobrychis arenaria and Onobrychis inermis reach a height of 113-141 cm and a productivity of 3.9-5.2 kg/m^{2}natural forage, with a nutritive value of 0.23-0.25 nutritive units/kg and a digestible protein content of 154.1-168.2 g/nutritive units, a high amount of carotene and a low amount of nitrates.*

Key words*: biological peculiarities, nutritional value, productivity, species of genus Medicago, species of genus Onobrychis.*

INTRODUCTION

Agriculture plays a strategic role in every country, since it is the main sector responsible for the food security and contributes to the overall process of sustainable economic development and environmental protection. The sustainable farming is very important to the modern agriculture because it ensures the balance between plant growing and animal husbandry. The development of animal husbandry requires provision and diversification of forage production to make it balanced in terms of quantity and quality throughout the year, according to the physiological requirements of animals and the stability of animal production that will meet the market requirements. In the last 20 years, the area of the agricultural lands cultivated with forage crops has considerably reduced, the grasslands and the hayfields in Moldova have highly degraded, their productivity is very low and the share of forage leguminous plants is decreasing year by year (BAHCIVANJI ET AL., 2012).

Forage legumes are an essential component of agricultural systems in temperate regions of the world. The benefits of forage legumes include providing top quality animal feed, suitable ground cover, and a valuable source of nitrogen. The nitrogen fixing ability of the legume occurs through inoculation with rhizobia. The root nodules contain the rhizobia, which have a symbiotic relationship with the legume allowing for the fixation of nitrogen for the plant. In return, the legumes supply the rhizobium bacteria with a source of fixed carbon derived from the photosynthetic process. This allows the legumes to survive and grow with little or no nitrogen added to the soil. When legumes are used as cover crops they contribute large amounts of nitrogen to the soil for uptake by the subsequent crop (DUKE , 1981; LEWIS ET AL., 2005; LÜSCHER ET AL., 2013). The genus *Medicago* L. of the family *Fabaceae* Lindl., subfamily *Papilononoidae*, tribe *Trifolieae*, comprises 3 subgenera and 87 species (SMALL, 2011), in

our country, only six species. Alfalfa *Medicago sativa* L. is often cultivated as a forage crop (BOLTON, 1962; LUPASCU, 2004, MEDVEDEV AND SMETANNIKOVA, 1981; STAVARACHE ET AL., 2012).

Because of the consequences of climate change (desertification, salinization), the species of the genus *Onobrychis* Mill., subfamily *Faboideae*, tribe *Hedysareae*, native to Eurasia (about 150 species are currently known) deserve special attention. They are resistant to frost and drought, grow well on poor, eroded, rocky or dry soils, providing good yields even in these conditions. The animals can eat these plants, which unlike *Medicago* species do not cause bloating (GOPLEN ET AL., 1980; LEES, 1992; LEWKE BANDARA ET AL., 2013; ZARRABIAN ET AL., 2013)

After over six decades of scientific research on plant resource mobilization, the Collection of nontraditional forage plants of the Botanical Garden (Institute) of the ASM has been founded. It includes over 300 species and cultivars, among them – 76 forage leguminous plants. There are 26 species of the genus *Medicago* L. and 5 species of the genus *Onobrychis* Mill., from different floristic regions of Central and South Europe, Caucasus, Central Asia. The seed material was collected during expeditions and by international seed exchange.

The areas where forage crops grow need to be expanded and the range of forage leguminous crops needs to be widened in order to improve forage productivity and quality. For this purpose, it is necessary to study the biological peculiarities, productivity, biochemical composition and nutritional value of native and introduced species. These issues have determined the choice of the object of study.

MATERIALS AND METHODS

As research subjects were used species of the genus *Medicago* L.: from the local flora *M. falcata* L., from the Central European flora – *M. varia* Mart. and *M. borealis* Grossh., from Caucasian flora – *M. hemicycla* Grossh. and *M. polychroa* Grossh., from Central Asian flora – *M. difalcata* Sinsk. and *M. tianschanica* Vass.; species of the genus *Onobrychis*: from the local flora – *O. arenaria* (Kit.) DC, from Caucasian and Crimean flora – *O. inermis* Steven, and, the traditional leguminous crops: alfalfa, *Medicago sativa* L., common sainfoin, *Onobrychis viciifolia* Scop. were used as control variant. The experiments were performed on non-irrigated experimental land in the Botanical Garden (Institute) of the ASM, on usual chernozem. They started in spring, when the soil had reached the physical maturity. The seeds were planted at a depth of 1.5-2.0 cm with soil compaction before and after sowing. The evidence area of the plot was of 10 m^2. The number of repetitions – 4. The scientific researches on growth and development, productivity and nutritional value of the plants were carried out according to the methodical indications (NOVOSELOV ET AL., 1983; PETUKHOV ET AL., 1989).

RESULTS AND DISCUSSIONS

We found, after performing phenological observations (Tab. 1), that the studied species of the genus *Medicago* L. differed significantly in the period of seed germination and seedling emergence at the soil surface. The seedlings of *M. tianschanica* emerged at the soil surface after 7 days, that is 4 days earlier than the control *M. sativa* and *M. varia*, but for the species *M. falcata* and *M. agropyretorium*, this period started 5 days later in comparison with the control. *M. hemicycla* needed a longer period until the formation of flower buds, about 76 days, in comparison with the control. The flowering period and seed ripening of *M. varia* and of the control started at the same time, but, for the other studied species, this period started 9-51 days later. A very long period of flower bud formation, flowering and seed ripening is characteristic of the species: *M. hemicycla*, *M. borealis* and *M. polychroa*.

Analysing the species of the genus *Onobrychis*, we found that the seeds of *O. inermis* needed a longer period for germination, but, from the emergence of seedlings at the soil surface to flowering, the plants develop faster.

Table 1.

Biological peculiarities and productivity of plants of the genera *Medicago* and *Onobrychis*

Indices	*M. sativa*	*M. falcata*	*M.varia*	*M. borealis*	*M. tianschanica*	*M. difalcata*	*M. hemicycla*	*M. polychroa*	*O. viciifolia*	*O. arenaria*	*O. inermis*
Sowing - seedling emergence, days	11	16	11	14	7	15	7	16	15	15	20
Em. of seedlings – flower buds, days	57	63	61	57	55	60	76	63	75	76	72
Em. of seedlings – flowering, days	68	83	69	92	72	77	102	88	99	98	94
Ripening of seeds, days	112	144	111	159	121	147	163	154	133	135	135
Plant height at flowering, cm	97	82	108	87	83	85	77	72	105	113	141
First harvest											
- natural forage, kg/m^2	1.68	1.36	2.02	1.57	2.14	1.29	1.03	1.79	3.9	4.1	5.2
- dry matter, kg/m^2	0.46	0.36	0.54	0.46	0.66	0.39	0.31	0.48	0.92	1.11	1.53

The growth rate of the studied species differed. Thus, in the flowering period, the *M. varia* plants were the tallest – 108 cm, by 11 cm taller than the control, and *M. polychroa* plants were the shortest – 72 cm.

The researched *Onobrychis* species grew much higher than *O. viciifolia*, so, *O. arenaria* reached 113 cm tall, and *O. inermis* – 141 cm.

The growth and development rates influence the accumulation of natural forage and dry matter. The species *M. tianschanica* had a high productivity of fresh mass at the first mowing – about 2.14 kg/m^2, 27% higher as compared with the control, but the species *M. varia* and *M. polychroa* – 1.79-2.02 kg/ m^2. *M. hemicycla* plants had a very low productivity of natural forage at the first harvest because they were small.

A higher rate of biomass accumulation is characteristic of the studied *Onobrychis* species, the natural forage yield reached values of 3.9-5.2 kg/m^2.

MEDVEDEV AND SMETANNIKOVA, 1981, noted that the productivity of the species *M. tianschanica* reaching 35-47 t/ha, *M. borealis*-18-24 t/ha and *M. falcata*- 11-15 t/ha, *O. arenaria* exceeded *O. viciifolia* by 20-70%.

The species *M. tianschanica, M. difalcata, M. borealis* and *O. inermis* are characterised by a high dry matter content in the harvested forage, reaching 30-31% and exceeding by far the traditional crops.

The biochemical composition and digestibility of the dry matter from the natural forage influences nutritional value, the health and the productivity of animals. Protein substances are essential as a limiting factor for the manifestation of the productive potential. The crude protein content in the studied species (Table 2) was of 4.87 % in *M. sativa* and *M. falcata*, reaching 6.06-6.21 % in *M. polychroa* and *M. varia*, the species *M. difalcata* had the lowest protein content in the natural forage – 4.21 %. *O. inermis* is characterised by a high content of crude protein.

The studied species are distinguished by a high content of fat. The 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 they contribute to the accumulation of fat in milk. The researched *Onobrychis* species contain more fat. *M. polychroa* and *M. tianschanica* are also characterised by a high fat content in forage: 0.71-1.00%.

Table 2.

Biochemical composition and nutritional value of natural forage of the genera *Medicago* and *Onobrychis*

Indices	*M. sativa*	*M. falcata*	*M.varia*	*M. borealis*	*M. tianschanica*	*M. difalcata*	*M. hemicycla*	*M. polychroa*	*O. vicitifolia*	*O. arenaria*	*O. inermis*
Crude protein, %	4.87	4.87	6.21	5.13	5.64	4.21	5.82	6.06	4.78	4.73	5.60
Crude fat, %	0.47	0.58	0.48	0.55	0.71	0.58	0.63	1.00	0.93	0.97	1.05
Crude cellulose, %	10.47	10.20	9.54	11.32	11.75	12.13	10.88	11.42	9.63	8.11	8.76
NFE, %	11.20	8.65	11.19	12.17	10.39	14.25	8.58	11.87	10.35	11.39	8.58
Minerals,%	2.50	2.20	2.78	2.63	2.51	2.33	2.58	2.65	1.71	2.01	2.58
1 kg natural forage contains:											
Nutritive units	0.20	0.17	0.25	0.22	0.20	0.23	0.18	0.23	0.22	0.23	0.25
- metabolizble energy, MJ/kg	2.63	2.33	2.86	2.83	2.73	3.02	2.48	2.95	2.26	2.56	2.76
- digestible protein, g/kg	33.51	36.52	49.06	38.46	42.29	31.56	43.69	45.48	35.87	35.45	42.04
Digestible protein, g/n.u.	182.6	214.8	196.2	174.8	211.6	137.2	242.7	198.2	163.1	154.1	168.2

The cellulose content in feed, its insufficiency, but in most cases its excess, adversely affects the metabolic processes of the body. The harvested forage of *Onobrychis* species had moderate cellulose content (8.11-8.76%), but *Medicago* species had high cellulose content, especially *M. difalcata* (12.13 %). *M. varia* is characterized by a lower cellulose content in forage (9.54%).

The nitrogen free extractive substances (NFE) consist of soluble mono and polysaccharides (sugar, starch etc.) and provide animals with energy necessary for vital processes, contributing to the formation and storage of fat. The species *M. difalcata, M. borealis* and *O. arenaria* are distinguished by a high content of nitrogen free extractive substances (NFE), but *M. hemicycla, M. falcata, M. tianschanica* and *O. inermis* – by a lower one.

The presence of minerals in animal feed is indispensable for growth and health, because they are essential components of all tissues and organs that maintain a constant osmotic pressure, participate in regulation of acid-base balance, activate a number of enzymes, moderate neuromuscular activities and prevent the emergence and development of animal diseases. *M. hemicycla, M. borealis, M. polychroa* and *M. varia* plants contain a higher amount of minerals, in comparison with *M. sativa*, but *M. falcata* and *M. difalcata* – a lower one. The species *O. arenaria* and *O. inermis* are characterised by a high amount of minerals in forage.

The organic matter content, the chemical composition and the digestibility determine the nutritional value of the forage. 100 kg of natural forage, of the researched species, contains 17-25 nutritive units. Analyzing the amount of metabolizable energy for cattle, we concluded that *M. difalcata, M. polychroa, M. varia* and *O. inermis* surpass by far the traditional leguminous crops.

The natural forage of the studied species of the genera *Medicago* and *Onobrychis* contains an amount of digestible protein that meets the zootechnical standards, so, a nutritive unit contains 137.2-242.7 g of digestible protein, and the forage of M. hemicycla is characterised by the highest content of digestible protein.

Vitamins are in very small quantities, but still play a crucial role in obtaining the desired animal products. Carotene is a precursor of vitamin A. The carotene content in the studied

Onobrychis species is much higher than in *Medicago* species. High carotene content was found in *M. polychroa, M. hemicycla, M. difalcata, M. borealis* and *M. tianschanica* (8.5-13.0 mg/kg), 1.9-2.9 higher than in *M. sativa*.

Analyzing the nitrate content of natural forage of the researched species, we could mention that *Onobrychis* species accumulate a lower amount of nitrates: 79-166 mg/kg, but the species *M. difalcata, M. tianschanica* and *M. hemicycla* are characterized by a very high nitrate content of 649-941 mg/kg, which may adversely affect animal health.

CONCLUSIONS

The species *Medicago tianschanica*, *Medicago varia* and *Medicago polychroa* have a productivity of 1.79-2.14 kg/m^2 natural forage, at the first harvest, surpassing by 9-27% *Medicago sativa*, with a nutritive value of 0.20-0.25 nutritive units/kg and a digestible protein content of 196.2-211.6 g/nutritive unit.

The species *Onobrychis arenaria* and *Onobrychis inermis*, at the first harvest, reach a height of 113-141 cm and a productivity of 3.9-5.2 kg/m^{2}natural forage, with a nutritive value of 0.23-0.25 nutritive units/kg and a digestible protein content of 154.1-168.2 g/nutritive units, a high amount of carotene and a low amount of nitrates.

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

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