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AGRO-BIOLOGICAL PECULIARITIES AND THE FORAGE QUALITY OF *ASTRAGALUS GALEGIFORMIS* L. UNDER THE CONDITIONS OF MOLDOVA

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Abstract

Efficient animal-based agriculture is sustained by the cultivation of legumes. Forage legumes have the unique attributes of producing high-quality forage to enhance animal performance and the ability to utilize symbiotic nitrogen. Perennial legumes of the genus Astragalus are promising subjects in the search of new species and forms for introduction and breeding. We investigated some agro-biological peculiarities and the forage quality of Astragalus galegiformis, cv. 'Vigor' grown in an experimental field of the National Botanical Garden (Institute), Chişinău. We found that the first cutting green mass contained 21.9% dry matter, but second and third cutting green mass – 31.9-34.2% dry matter. The dry matter of whole plant contained 231-234 g/kg CP, 111-126 g/kg ash, 247-248 g/kg ADF, 378-401 g/kg NDF, 31-38 g/kg ADL, 209-217 g/kg Cel, 131-153 g/kg HC, 188 g/kg TSS,83.2- 87.52% DMD, 75.3- 82.3% DOM and RFV = 161-171, 13.6 MJ/kg DE, *11.2* MJ/kg ME, *7.2* MJ/kg NEl. *The fermented fodder from Astragalus galegiformis 'Vigor', contained 227-194 g/kg CP, 320-335 g/kg CF, 127-143 g/kg ash, 334-343 g/kg ADF, 518-524 g/kg NDF, 39-43 g/kg ADL, 34-92 g/kg TSS, 295-300 g/kg Cel, 175-190 g/kg HC, with nutritive value: 70.6-74.0% DMD, 63.0-66.0% OMD, 12.26-12.39 MJ/kg DE, 10.07-10.17 MJ/kg ME and 6.09-6.40 MJ/kg NEl. The cultivar 'Vigor' of Astragalus galegiformis can be used as natural and fermented fodder for farm animals.*

Key words: *Astragalus galegiformis, biochemical composition, forage quality, cv. 'Vigor'*

INTRODUCTION

In recent years, the advances in plant and animal breeding, the introduction of new plant species and the development of new management approaches have made it possible to increase animal performance. Forage production in all of its ramifications is of major importance to agriculture. The use of high-quality forage crops will increase the efficiency of livestock programs, encourage the adoption of good soil fertility and pasture management techniques and hasten the movement away from practices inimical to the protection of soil resources and the environment. Efficient animal-based agriculture is sustained by legumes.

Perennial forage legumes are particularly valuable components of permanent and temporary grasslands, have the unique attributes of producing a high-quality forage and nutritional value to enhance animal performance and the ability to utilize atmospheric symbiotic nitrogen fixation, decrease the need for nitrogen fertilization and reduce forage costs. Nitrogen produced by legumes has the advantage of being available over a longer period, possesses a stimulating effect on crop yields and plays an important role in organic farming.

The genus *Astragalus* L. is one of the most important genera in the *Fabaceae* family, it is widely distributed throughout the temperate and arid regions of the world, but is particularly abundant in the temperate regions of North America, Europe and Asia. It has been estimated to contain about 3000 species as annual or perennial herbs, subshrubs, or shrubs. These invaluable plants are widely used as medicines, food, fodder, fuel and as ornamental plants in different ethnobotanical practices throughout the world. In pharmacological studies, *Astragalus* species showed anti-inflammatory, immunostimulant, antioxidative, anti-cancer, antidiabetic, cardioprotective, hepato-protective, and antiviral activities. (Li et al., 2014; Amiri et al., 2020). Recently, a lot of research and work has been done on the introduction and breeding of various species of the genus *Astragalus*. Among them, the most promising forage species are: *Astragalus adsurgens* Pallas, *Astragalus asper* Jacq., *Astragalus brevidens* (Gand.) Rydb., *Astragalus cicer* L., *Astragalus davuricus* (Pall.) DC., *Astragalus dasyanthus* Pall., *Astragalus galegiformis* L., *Astragalus falcatus* Lam., *Astragalus inopinatus* Boriss, *Astragalus falcatus* Lam., *Astragalus membranaceus* (Fisch.) Bunge*,* *Astragalus onobrychis* L., *Astragalus ponticus* Pall., *Astragalus schelichowii* Turcz., *Astragalus sulcatus* L., *Astragalus uliginosus* L. (Ye et al., 1996; Ostapko & Shinkarenko, 2003; Boraeva & Bekuzarova, 2010; Yu et al., 2010; Asaadi, & Yazdi, 2011; Xu et al., 2011; Phelan et al., 2015; Cacan et al., 2017; Naseri et al., 2017; Kornievskaya & Silanteva, 2018; Rakhmetov et al., 2018; Bondarchuk, 2019; Lardner et al., 2019; Dmitriev, 2020).

Astragalus galegiformis L., syn.: *Astragalus galegifolius* L., *Tragacantha galegiformis* (L.) Kuntze. is a caulescent, herbaceous perennial, native to the Caucasus Mountains, occurs in Eastern Europe, it grows in subalpine meadows, deciduous forests, scrublands and on river banks. Plant develops light green or grayish erect stems, which usually grow about 150-200 cm tall. The compound leaves are grey-green, glabrous on the upper side and sparsely hairy on the lower side, 8-15 cm long, oblong-ovate, 12-25 mm long; the stipules are 3-10 mm long, linear-lanceolate. Peduncles 7-14 cm long. The flowers are shortly pedicellate, pendulous, in lax, cylindrical, 30-40-flowered racemes. The bracts are 6-8 mm long, linear. The calyx is about 5 mm long, campanulate, with sparse and short black hairs and with 2-3 mm long, subulate to triangular teeth. The corolla is pale yellow; the keel 14-16 mm long. It blooms in May-June, is cross pollinated, produces fruits in July. *Astragalus galegiformis* is an excellent source of nectar and pollen for honeybees, melliferous potential is 200-300 kg of honey per hectare. The pods are 12-15 mm long, plano-convex, laterally compressed, glabrous, long-stipitate, mucronate, containing 4-6 seeds. The seeds are kidney-shaped or elliptical, strongly compressed on the sides, seed scar rounded with pale surrounded by 3.7-3.9×2.5-2.7 mm. The surface is smooth, shiny, greenish-brown or brown. The weight of 1000 seeds are 9-13 g. It produces a strong tap root, reaching a depth of 150-200 cm in the soil.

The aim of this study was to determine some agro biological peculiarities and the forage quality of *Astragalus galegiformis* under the conditions of Republic of Moldova.

MATERIALS AND METHODS

The cultivar 'Vigor' of *Astragalus galegiformis,* created at the "Alexandru Ciubotaru" National Botanical Garden (Institute), registered in the Catalogue of Plant Varieties* and cultivated in monoculture in the experimental plot, Chişinău, latitude 46°58′25.7″N and longitude 28°52′57.8″E, served as subject of the research, and the traditional leguminous forage crop alfalfa, *Medicago sativa* was used as control.

The green mass, in the second year, was harvested manually, at 10 cm stubble height. The first cutting samples were collected in early flowering stage, May, 14, the second cutting – July, 27, the third cutting – October, 22. The green mass productivity was determined by weighing the yield obtained from a harvested area of 10 m^2. The leaves/stems ratio was determined by separating leaves from the stem, weighing them separately and establishing the ratios for these quantities; samples of 1.0 kg harvested plants were used. 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. For ensiling, the harvested whole plants were shredded and compressed in well-sealed containers. The haylage was prepared from wilted green mass, shredded and compressed in well-sealed glass containers. After 45 days, the containers were opened, and the organoleptic assessment and the biochemical composition of the silage and haylage was determined in accordance with the Moldavian standard SM 108**. 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), total soluble sugars (TSS), digestible dry matter (DDM), digestible organic matter (DOM) have been determined by near infrared spectroscopy (NIRS) technique PERTEN DA 7200 of the Research and Development Institute for Grassland Braşov, Romania. The concentration of hemicellulose

(HC) and cellulose (Cel), the digestible energy (DE), the metabolizable energy (ME), the net energy for lactation (NEl) and the relative feed value (RFV) were calculated according to standard procedures.

RESULTS AND DISCUSSIONS

As a result of the performed research, it has been found that, in order to germinate abundantly, the seeds of *Astragalus* need to be scarified. In the first year of vegetation, the growth and development rates of *Astragalus galegiformis* were low in comparison with *Medicago sativa*, *Lotus corniculatus* and *Onobrychis viciifolia,* the shoots were prostrate, thin, and about 47-91 cm long at the end of the growing season. In the second year, the growth and development of *Astragalus galegiformis* plants began when the average temperature was above 0°C, in the end of March. It was established that the revival of *Astragalus galegiformis* 'Vigor' plants from dormant buds was uniform, characterized by faster grow and development rates. At the time when the first cutting green mass was harvested, the erect shoots reached 118 cm, the yield was 65.54 t/ha green mass or 10.58 t/ha dry matter, containing 53.5% leaves in the harvested mass (Table 1). After the first cut, under unfavourable weather conditions, the plants grew back slower, shoots developed from large buds, which were located just above the collar. *Astragalus galegiformis* plants were cut for the second time in late July, obtaining 15.97 t/ha green mass or 5.79 t/ha dry matter, the harvested mass was poor in leaves (31.7%). The lack of rainfall and the very high air temperatures during August to the first half of September affected the regeneration and development rate of *Astragalus galegiformis* 'Vigor' plants. The formed shoots were prostrate, thin and over 33-41 cm long, with moderate proportion of leaves (54.5%) and dry matter content (26.8%). The yield, at the third cut, decreased essentially in comparison with the previous cuts. Other researchers (Boraeva & Bekuzarova, 2010; Chibis et al., 2011) have also mentioned the slow regrowth of *Astragalus galegiformis* plants after mowing.

The annual productivity of *Astragalus galegiformis* 'Vigor', in the second growing season, reached 87.33 t/ha green mass or 17.93 t/ha dry matter.

As a result of a research conducted by Rakhmetov et al. (2018) in the Right Bank of Forest-Steppe of Ukraine, it has been found that the yield of *Astragalus galegiformis* was 126.6 t/ha green mass or 26.53 t/ha of dry mass; *Astragalus ponticus* - 98.7 t/ha green mass or 21.34 t/ha of dry matter; *Astragalus cicer* - 56.7 t/ha green mass or 11.21 t/ha of dry matter.

Table 1. Some agrobiological peculiarities of *Astragalus galegiformis* and the structure of the harvested mass depending on the harvest time

Harvest time	Plant height, cm	Stem, g		Leaf, g		Productivity, t/ha		Content of leaves in fodder, %
		green mass	dry matter	green mass	dry matter	green mass	dry matter	
First cut	118	105.0	14.4	87.5	16.6	65.54	10.58	53.5
Second cut	56	8.1	2.8	3.2	1.3	15.97	5.79	31.7
Third cut	36	4.2	1.0	4.0	1.2	5.82	1.56	54.5

Forage plants are valuable because they serve as food for wild and domesticated herbivores and sustain the production of meat, milk and other commodities. Forage plants contain different quantities of fibre, lignin, minerals and protein, and vary in the proportion of their tissue that can be digested by herbivores. These nutritive components are important determinants of consumer growth rates, reproductive success and behaviour (Lee, 2018). The productivity, the quality and the seasonal distribution of forage may be of great importance to the livestock farmers. The chemical composition, protein and carbohydrate fraction profiles, and predicted nutritional and energy values for *Astragalus galegiformis* green mass forages are shown in Table 2. Analysing the quality of the green mass of the cultivar 'Vigor' of *Astragalus galegiformis*, we found that the dry matter content and its chemical composition varied in comparison with alfalfa. Protein is a key nutrient that must be considered both in terms of amount and type for various animal diets. It has been found that the cultivar 'Vigor' is characterized by high content of protein in dry matter (231-234 g/kg) and low content of crude fibre (224-233 g/kg) in comparison with *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 in animals (McDonald et al., 2010). We could mention that the first cutting green mass of *Astragalus galegiformis* contains high amounts of minerals (126 g/kg), but the second cutting green mass - low amounts of minerals (111 g/kg), in comparison with traditional leguminous forage crops. The total amount of soluble sugars in *Astragalus galegiformis* forage reached 188 g/kg, which was twice more than in *Medicago sativa* forage.

Table 2. The biochemical composition and forage quality of the green mass

Indices	*Astragalus galegiformis*		*Medicago sativa*
	First cut	Second cut	First cut
Crude protein, g/kg DM	234	231	207
Crude fibre, g/kg DM	233	224	270
Ash, g/kg DM	126	111	121
Acid detergent fibre, g/kg DM	248	247	280
Neutral detergent fibre, g/kg DM	401	378	398
Acid detergent lignin, g/kg DM	31	38	42
Total soluble sugars, g/kg DM	188	-	92
Cellulose, g/kg DM	217	209	238
Hemicellulose, g/kg DM	153	131	118
Dry matter digestibility, %	87.5	83.2	73.9
Organic matter digestibility, %	82.3	75.3	66.4
Digestible energy, MJ/kg	13.58	13.61	13.15
Metabolizable energy, MJ/kg	11.15	11.17	10.79
Net energy for lactation, MJ/kg	7.17	7.18	6.81
Relative feed value RFV	161	171	157

Plant cell walls provide mechanical strength, maintain cell shape, control cell expansion, regulate transport, play important roles in plant responses to various abiotic stresses, such as drought, flooding, heat, cold, and salt and are essential for the storage of food reserves. Cell wall components such as NDF, ADF, cellulose, hemicellulose and lignin are very important limiting factors to the feeding processes and to the ability of the animal to utilize the consumed forage. The amount of neutral detergent fibre in the first cutting green mass of *Astragalus galegiformis* did not differ significantly from *Medicago sativa,* but it was substantially lower in the second cutting green mass of *Astragalus galegiformis*. It was found that the concentrations of cellulose and lignin, in the green mass of *Astragalus galegiformis*, were low and those of hemicellulose – high, which had a positive effect on dry and organic matter digestibility, relative feed value and energy content. Besides, the *Astragalus galegiformis* forage had 83.2-87.5% DMD, 75.3-82.3% OMD, RFV=161-178, 13.6 MJ/kg DE, 11.2 MJ/kg ME, 7.2 MJ/kg NEl, but the *Medicago sativa* forage - 73.9% DMD, 66.4% OMD, RFV = 157, 13.20 MJ/kg DE, 10.8 MJ/kg ME and 6.8 MJ/kg NEl, respectively.

Some authors mentioned various findings about the green mass quality of *Astragalus* species. Davis (1982) remarked that *Astragalus galegiformis* contained 34.7% dry matter with 15.5% crude protein, 15.1% crude fibre, 7.7 mg/g tannin and 0.34% oxalate. According to Ostapko & Shinkarenko (2003), the chemical composition of *Astragalus cicer* natural fodder was 18.1% crude protein, 4.1% crude fats, 26.4% crude cellulose, 9.9% sugars; *Astragalus falcatus* fodder contained 19.1% crude protein, 4.7% crude fats, 21.9% crude cellulose, 11.6% sugars; *Astragalus galegiformis* - 25.1% crude protein, 3.2% crude fats, 26.2% crude cellulose, 8.6% sugars and *Astragalus onobrychis* - 17.5% crude protein, 2.9% crude fats, 21.1% crude cellulose, 11.8% sugars. Kshnikatkina et al. (2005) mentioned that the chemical composition of the dry matter of *Astragalus galegiformis* was: 17.39% crude protein, 1.76% crude fats, 25.56% crude cellulose, 4.56% ash, 1.2% calcium and 0.8% phosphorus. Boraeva & Bekuzarova (2010) remarked that *Astragalus galegiformis* contained 18.77% crude protein, 43.88% crude cellulose, 3.11% sugars, but *Galega orientalis* - 16.48% crude protein, 35.78% crude cellulose, 2.7 % sugars. Xu et al. (2011) mentioned that, a whole plant of *Astragalus adsurgens*, harvested in the budding stage, contained 290 g/kg dry matter with 14.4% crude protein, 45.5% NDF, 30.3% ADF, 8.1% ADL, 4.7% WSC. Asaadi &Yazdi (2011) found that under the climatic conditions of dry rangelands of Iran, the chemical composition and the energy value of *Astragalus brevidens* harvested in the flowering stage were 14.45% crude protein, 47.85% ADF, 50.22 % DMD and 6.54 MJ/kg metabolizable energy, respectively. Chibis et al. (2011) found that the concentrations of nutrients and energy in the first cutting green mass of *Astragalus galegiformis* were 17.2% crude protein, 2.7% crude fats, 25.7% crude cellulose, 8.8% minerals, 45.6% nitrogen free extract, 0.78 nutritive units/kg, 11.9 MJ/kg metabolizable energy and 144 g digestible protein per nutritive unit, but in the second cutting green mass – 20.89% crude protein, 2.9% crude fats, 22.4% crude cellulose, 8.7% minerals, 45.2% nitrogen free extract, 0.79 nutritive unit/kg, 11.3 MJ/kg metabolizable energy and 149 g digestible protein per nutritive unit. Amiri et al. (2012), remarked the forage quality of *Astragalus macropelmatus* growing in Zagros semi-arid rangeland centre in Iran: 13.12% protein, 3.33% fat, 8.54% ash, 47.27% NDF, 28.64% ADF, 65.57% DMD, 9.32 MJ/kg metabolizable energy and RFQ=131. Teleuță et al. (2015) found that the natural fodder from *Astragalus galegiformis* contained 17.64% crude protein, 3.69% crude fats, 23.21% crude cellulose, 48.47 % nitrogen free extract, 7.00% ash, *Galega orientalis* -17.80% crude protein, 3.55% crude fats, 30.50.21% crude cellulose, 39.47 % nitrogen free extract, 8.69% ash and *Medicago sativa* -16.16% crude protein, 1.88% crude fats, 34.74% crude cellulose, 37.22% nitrogen free extract, 10.00% ash. Hou et al. (2017) mentioned that, under the conditions of meadow steppe in China, the chemical composition of *Astragalus melilotoides* harvested in full-bloom stage was as follows: 36.51% DM, 95.91% OM, 12.08% CP, 1.97% fats, 59.73% NDF, 48.95% ADF. Naseri et al. (2017) mentioned that *Astragalus fridae* green mass harvested in the flowering stage contained 7.8% protein, 38.96 crude fibre, 45.20% NDF, 26.98% ADF, 6.98% ash, 66.08% DMD, 9.23 MJ/kg metabolizable energy. Uskov et al. (2017) found that the concentrations of nutrients and energy in harvested green mass of *Astragalus galegiformis* were 46.1 g/kg crude protein, 32.5 g/kg digestible protein, 11.6 g/kg crude fats, 59.3 g/kg crude cellulose, 95.8 g/kg nitrogen free extract, 22.8 g/kg minerals and 2.34 MJ/kg metabolizable energy. Cacan et al. (2017) mentioned that the green mass of *Astragalus onobrychis* harvested in the flowering stage contained 20.07 % crude protein, 0.63 crude fats, 47.14% NDF, 18.3% ADF, 7.05% ash, 55.48% DMD, 8.01 MJ/kg metabolizable energy. Lardner et al. 2019 remarked the chemical composition of *Astragalus cicer* fresh forage, which contained 31.8-33.4% dry matter, 16.1-16.9% crude protein, 2.1-2.5% crude fats, 41.8-46.1% NDF, 34.0-37.5% ADF, 7.2-7.7% ADL, 7.8-8.0% ash, 1.14-1.27% calcium, 0.18-0.22% phosphorus, RFV=127-139, but *Medicago sativa* fresh forage – 32.4% dry matter, 14.1% crude protein, 2.4% crude fats, 54.2% NDF, 43.2% ADF, 8.3% ADL, 7.4% ash, 1.41% calcium, 0.18% phosphorus, RFV=93. Makarov (2017) revealed that the species *Astragalus uliginosus* contained 26.75-30.48% crude protein, 1.94-2.53% crude fats, 17.76-22.71% crude cellulose, 9.91-10.34% minerals, 1.90-1.93% calcium, 0.29-0.32% phosphorus, 34.88-41.95% nitrogen free extract, 10-15 mg/% carotene. *Astragalus sulcatus* contained 25.6% crude protein, 2.5% crude fats, 16.5% crude cellulose, 7.5% minerals, 1.2% calcium, 0.3% phosphorus, 47.0% nitrogen free extract. *Astragalus davuricus* contained 26.2% crude protein, 1.4% crude fats, 21.5% crude cellulose, 10.9% minerals, 1.3% calcium, 0.5% phosphorus, 40.2% nitrogen free extract.

Astragalus inopinatus contained 25.6% crude protein, 3.5% crude fats, 13.8% crude cellulose, 10.9% minerals, 2.2% calcium, 0.3% phosphorus, 45.5% nitrogen free extract. *Astragalus onobrychis* contained 25.5% crude protein, 2.3% crude fats, 20.6% crude cellulose, 7.8% minerals, 1.1% calcium, 0.3% phosphorus, 41.1% nitrogen free extract. Bondarchuk (2019) mentioned that, under the conditions of the Right-Bank Forest-Steppe of Ukraine, the biochemical composition of *Astragalus galegiformis* was: 20.91% crude protein, 455% crude fats, 4.69% ash, 34.84% crude cellulose, 45.6% nitrogen free extract, 0.65% calcium and 0.11% phosphorus.

It has been commonly accepted that one of the pre-requirements for the high productivity of farm animals in the developed regions of the temperate climate zone was the introduction and utilization of efficient methods of forage conservation. Farmers often prefer to feed the livestock with silage and haylage, because rainfall often hinders hay production. Under year-round uniform feeding, silage and haylage are the most effective types of the diet. Vegetables are good sources of quality protein for livestock. When forage legumes are adequately preserved, silage and haylage can help reduce subsequent feed costs and improve animal performance.

When opening the glass vessels with silage and haylage made from green mass of *Astragalus galegiformis*, obtained after the first cutting, a little gas was released, but there was no juice leakage from the preserved mass. The preserved forage materials had pleasing colour and aroma, the consistency was retained in comparison with the initial green mass, without mould and mucus. During the sensorial assessment, it was found that, in terms of colour, the silage had specific dark green leaves and greenish stems, with pleasant smell, specific to pickled vegetables, while the haylage contained homogeneous dark green leaves and brownish yellow stems with pleasant smell like pickled apples.

The fermentation quality of the silage and haylage from *Astragalus galegiformis* is demonstrated in Table 3. It has been determined that the amounts of organic acids reached 41.1- 55.3 g/kg and the pH was 4.31-4.78, most organic acids were in fixed form. The butyric acid was not detected in the fermented fodder. *Astragalus galegiformis* haylage was characterized by optimal pH values, high content of lactic acid and low content of acetic acid.

Table 3. The fermentation quality of the silage and haylage from *Astragalus galegiformis,* first cutting

Indices	silage	haylage
pH index	4.31	4.78
Total organic acids, g/kg	41.1	55.3
Free acetic acid, g/kg	5.3	2.6
Free butyric acid, g/kg	0	0
Free lactic acid, g/kg	5.3	11.5
Fixed acetic acid, g/kg	7.8	6.9
Fixed butyric acid, g/kg	0	0
Fixed lactic acid, g/kg	22.7	34.3
Total acetic acid, g/kg	13.1	9.5
Total butyric acid, g/kg	0	0
Total lactic acid, g/kg	28.0	45.8
Acetic acid, % total acids	31.87	17.18
Butyric acid, % total acids	0	0
Lactic acid, % total acids	68.13	82.82

The results of the biochemical studies (Table 4) indicate that the fermented fodder from *Astragalus galegiformis* 'Vigor' contained 227-194 g/kg CP, 320-335 g/kg CF, 127-143 g/kg ash, 334-343 g/kg ADF, 518-524 g/kg NDF, 39-43 g/kg ADL, 34-92 g/kg TSS, 295-300 g/kg Cel, 175-190 g/kg HC, with nutritive value: 70.6-74.0% DMD, 63.0-66.0% OMD, 12.26-12.39 MJ/kg DE, 10.07-10.17 MJ/kg ME and 6.09-6.40 MJ/kg NEl.

Table 4. The biochemical composition and the forage quality of the silage and haylage from *Astragalus galegiformis*

Indices	silage	haylage
Crude protein, g/kg DM	227	194
Crude fibre, g/kg DM	320	335
Ash, g/kg DM	143	127
Acid detergent fibre, g/kg DM	334	343
Neutral detergent fibre, g/kg DM	524	518
Acid detergent lignin, g/kg DM	39	43
Total soluble sugars, g/kg DM	34	92
Cellulose, g/kg DM	295	300
Hemicellulose, g/kg DM	190	175
Dry matter digestibility, %	74.0	70.6
Organic matter digestibility, %	66.0	63.0
Digestible energy, MJ/kg	12.39	12.26
Metabolizable energy, MJ/kg	10.17	10.07
Net energy for lactation, MJ/kg	6.40	6.09
Relative feed value	112	112

The concentrations of crude protein, ash and hemicellulose were high in *Astragalus* *galegiformis* silage. In haylage, the content of total soluble sugars was significantly higher.

Several literature sources have described the quality of fermented fodder from *Astragalus* species. According to Ye et al. (1996) the Chinese milkvetch (*Astragalus sinicus*) silage had pH = 4.1 and contained 18.9% CP, 54.9% NDF, 38.0% ADF, 3.3% ADL. Yu et al. (2010) found that the dry matter content and the concentrations of nutrients in the silage prepared from fresh mass of *Astragalus cicer* were: 21.92-23.22% DM, 17.80-17.91% CP, 47.05-48.84% NDF, 37.79-39.98% ADF, 10.30-11.75% ash, 3.88-3.95% fats, pH = 4.17-5.48, 6.2-19.9 g/kg lactic acid, 1.1-11.0 g/kg acetic acid, 0-0.6 g/kg butyric acid, but in the silage prepared from wilted mass – 36.50-37.97% DM, 18.16-19.39% CP, 47.55-48.45% NDF, 39.40-40.38% ADF, 10.07-10.08% ash, 3.91- 4.11% fats, pH = 4.51-4.85, 8.2-17.6 g/kg lactic acid, 2.6-8.2 g/kg acetic acid, butyric acid was not detected. Xu et al. (2011) revealed that dry matter content and the biochemical composition of silage from erect milkvetch (*Astragalus adsurgens*) treated with distilled water was: 259 g/kg, pH = 5.48, 17.6 g/kg lactic acid, 10.8 g/kg acetic acid, 5.8 g/kg butyric acid, 142 g/kg CP, 467 g/kg NDF, 315 g/kg ADF, 86 g/kg ADL, 7.1 g/kg WSC, 530 g/kg DMD, but the silages treated with inoculant and enzymes – 260 g/kg, pH = 4.83, 34.5 g/kg lactic acid, 7.8 g/kg acetic acid, 1.3 g/kg butyric acid, 161 g/kg CP, 407 g/kg NDF, 272 g/kg ADF, 74 g/kg ADL, 7.1 g/kg WSC, 602 g/kg DMD. Uskov et al. (2017) remarked that the silage from *Astragalus galegiformis* green mass conserved with benzoic acid contained 23 % dry matter with pH 4.2, 8 g/kg lactic acid and 4 g/kg acetic acid, 41.6 g/kg crude protein, 12.7 g/kg crude fats, 56.3 g/kg crude cellulose, 97.5 g/kg nitrogen free extract and 2.34 MJ/kg metabolizable energy in silage.

CONCLUSIONS

The cultivar 'Vigor' of *Astragalus galegiformis*, in the second growing season, was characterised by high growth rate and moderately regenerative capacity after being mowed, making it possible to cut it three times per season, obtaining 87.33 t/ha green mass or 17.93 t/ha dry matter.

The dry matter of the harvested whole plant contained 231-234 g/kg CP, 111-126 g/kg ash, 247-248 g/kg ADF, 378-401 g/kg NDF, 31-38 g/kg ADL, 209-217 g/kg Cel, 131-153 g/kg HC, 188 g/kg TSS, 83.2- 87.52% DMD, 75.3-82.3 % DOM and RFV= 161-171, 13.6 MJ/kg DE, 11.2 MJ/kg ME, 7.2 MJ/kg NEl.

The fermented fodder from *Astragalus galegiformis* 'Vigor', contained 227-194 g/kg CP, 320-335 g/kg CF, 127-143 g/kg ash, 334-343 g/kg ADF, 518-524 g/kg NDF, 39-43 g/kg ADL, 34-92 g/kg TSS, 295-300 g/kg Cel, 175-190 g/kg HC, with nutritive value: 70.6-74.0% DMD, 63.0-66.0% OMD, 12.26-12.39 MJ/kg DE, 10.07-10.17 MJ/kg ME and 6.09-6.40 MJ/kg NEl.

The cultivar 'Vigor' of *Astragalus galegiformis* can be considered as a promising forage legume to restore degraded soils and create temporary grasslands, and the harvested biomass can be used as natural and fermented fodder for farm animals.

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