

THE ANALYSIS OF FORAGE QUALITY FOR ORGANIC MILK PRODUCTION IN FRUŠKA GORA REGION

GRDOVIĆ SVETLANA*, SAVIĆ MILA*, JOVANOVIĆ S*, POPOVIĆ-VRANJEŠ ANKA**,
PETRUJKIĆ B* and BOSANČIĆ D***

**University of Belgrade, Faculty of Veterinary Medicine, R Serbia*

***University of Novi Sad, Faculty of Agriculture, R Serbia*

****Center for food quality research Ltd, Belgrade, R Serbia*

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*As a result of the growing demand for organic products, especially organic milk, the livestock organic production has increased. In this paper botanical and chemical composition of forage for organic dairy cow production in Fruška Gora region were analysed. In the mixed hay samples, species from the Poaceae family were classified, according to their nutritive value into the first class. Dominant presence of *Dactylis glomerata* L. and *Poa pratensis* was revealed. Lucerne hay was predominantly composed only by one leguminous species *Medicago sativa* L. Basic nutritive components of mixed and Lucerne hay: crude moisture, crude ash, crude protein, crude fat, crude cellulose, calcium (Ca), magnesium (Mg) phosphorous (P), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) were determined. Determined levels of hazardous and noxious substances (mycotoxins, pesticides and heavy metals) in all hay samples were in the range according to regulations.*

Botanical analysis has confirmed the presence of plants with high yield and of high nutritive value. Chemical analyses of hay samples originating from Fruška Gora has pointed out that the level of crude proteins, cellulose, fats, macro and trace elements can completely satisfy the requirements of animals in organic farming and therefore can present a solid base for further development of organic dairy farming.

Key words: forage, botanical composition, chemical composition, organic production

INTRODUCTION

During the past decade, the general attitude of the human population towards health, nutrition quality and environment has remarkably changed. As a result of the growing demand for organic products, especially organic milk, the livestock organic production has increased (Rosati, 2004; Von Borell, 2004; Sundrum, 2001).

Council regulations (EC) No 2092/91 and 1804/99 describe in detail the allowed organic livestock management in Europe. Great emphasis is placed on welfare friendly feeding. Principles of organic livestock feeding require that ruminant diets should be based on organic feeds in the form of a balanced ration that provides requirements for high quality products rather than maximizing output. Organic standards require that forage must comprise at least 60% of the dietary dry matter intake of the organic dairy cow. Aiming for self-sufficiency, organic farming is characterized as a low external input agro-ecosystem. According to organic production standards, all feed should come from the farm itself, or at least should be produced within the region (IFOAM 2002, 2005; Hass *et al.* 2007).

Fruška Gora is a low mountain in the flatlands of the Pannonian Plain. The valleys of Fruška Gora are covered with meadows and grain fields spread over its slopes, while its higher parts, above 300 meters, are covered with dense deciduous forests. Geographic conditions, good climate and soil conditions of Fruška Gora region promote an intensive use of pastures and meadows. Vegetation of Fruška Gora is characterised by different types of meadow and pastures which are composed from numerous species. Four types of pastures and meadows can be distinguished: lowland meadows, highland meadows and pastures, swamp meadows and pastures of the river valleys (Butorac, 1991). Each of the mentioned types, is rich with the most significant species of meadow-pasture grasses that are of importance in dairy cow nutrition.

In this paper, botanical and chemical composition of Lucerne and mixed hay samples originating from 8 localities of Fruška Gora region was investigated, as well as its self sufficiency for satisfying requirements for organic milk production.

Particular emphasis is laid on the amount of present toxic matters since they pose a threat to animal and human health (Horrigan *et al.*, 2002).

MATERIAL AND METHODS

Analyses of botanical composition

Hay samples from Fruška Gora mountain region were taken in a period from August to September 2009. Eight samples each from mixed and Lucerne hay were analyzed. Hay was properly conserved, all parts of the plant were preserved which has enabled exact botanical analyses. Plants species were determined by floral determination key (Flora Srbije VIII, 1976; Javorka and Csapody, 1991). Determined species were sorted into classes according to their nutrient value. Based on organoleptic properties and chemical composition hay quality was determined, consecutively scored and classified according to Lenient (1969). *Dactylis glomerata* L. hay grown in our region gives average yearly yield of 10 to 15 t/ha and *Poa pratensis* L. 7-10 t/ha. Lucerne hay in Vojvodina yields yearly 8.2 to 8.4 t/ha (Vučković *et al.*, 2002).

Analyses of chemical composition

Hay samples (n=16) were collected according to procedure AS-1064 (1993). Content of crude ash, crude protein, crude fat, crude cellulose and nitrogen free extract (NFE) was determined in relation to dry matter.

Sample preparation for analyses was done on a procedure according to AOAC (1990). Determination of basic nutritive components was done according to the following procedures: crude moisture SRPS ISO 6496/2001; crude ash SRPS ISO 5984/2002; crude protein SRPS ISO 5983/2001; crude fat SRPS ISO 6492/2001; and content of crude cellulose according to accredited laboratory method (DM1); while content of (NFE) was determined by calculation. Content of calcium (Ca) and magnesium (Mg) was determined by SRPS ISO 6869/2004 and phosphorous (P) by spectrophotometry. Content of trace elements, copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) was determined by atomic absorption spectrophotometry according to SRPS ISO 6869/2004.

Presence of aflatoxins (B₁ + G₁) was investigated by enzyme linked immune assay ELISA, IHM-03-007. Presence of mercury and arsenic was determined by hydride generated atomic absorption spectrophotometry (HGAAS, IHM-03-001); cadmium and plumb by graphite furnace atomic absorption spectrophotometry (GFAAS, IHM-03-001). Presence of organophosphate insecticides (hch, lindane, aldrine and dieldrine, heptachlor and heptachlor dioxide, DDT, endrine, endosulphane) was determined by gas chromatography according to procedure GC-ECD, IHM-03-002.

All mentioned procedures comply with the Rule Book for Feed Sampling and Analyses (Sl. list SFRJ br. 15/87), as well as with Animal Feed Rule Book (Sl. list SRJ br. 20/00 and 38/01).

A statistical analysis of samples was done by GraphPad Prism, descriptive statistical parameters were used (Xsr, SD and CV).

RESULTS

By botanical analyses in samples of the mixed, as well as in lucerne hay samples the presence of grass species of high nutritive value was determined. Species determined in the mixed hay samples, were classified, according to their nutritive value into first class. Presence of following species from Poaceae family was revealed: *Dactylis glomerata* L., *Poa pratensis* L., *Alopecurus pratensis* L., *Lolium perenne* L., *Arrhenatherum elatius* (L.) M.et Koch and *Agropyrum repens* (L.) P.B.. From Fabaceae family following species were present: *Trifolium pratense* L., *Trifolium repens* L. and *Lotus corniculatus* L. Determined dominant species in the mixed hay samples were *Dactylis glomerata* L. and *Poa pratensis* L.. Medical herbs, such as: *Achillea millefolium* L., *Plantago media* L., *Teucrium chamaedrys* L. and *Taraxacum officinale* Web. were also present. All mixed hay samples were with pleasing aroma, green colour and without notable presence of dust and smack and were classified into second class of hay (hay of good quality).

Lucerne hay was predominantly composed only by one leguminous species *Medicago sativa* L. Colour of Lucerne hay was greenish, with pleasing aroma and therefore classified into first class (hay of very good quality).

Chemical composition of hay samples is shown in Table 1. Presence of toxic maters (mycotoxins, pesticides and heavy metals) is shown in Table 2.

Table 1. Chemical composition of hay samples

Parameter		Mixed hay (n=8)	Lucerne hay (n=8)
Moisture (% DM)	Xsr \pm SD	13.70 \pm 0.46	13.01 \pm 0.57
	CV %	3.37	4.38
Crude ash (% DM)	Xsr \pm SD	7.69 \pm 0.84	7.88 \pm 0.31
	CV %	10.93	3.88
Crude protein (% DM)	Xsr \pm SD	10.13 \pm 0.70	16.32 \pm 0.48
	CV %	6.94	2.92
Crude fat (% DM)	Xsr \pm SD	1.04 \pm 0.13	0.88 \pm 0.08
	CV %	12.21	9.33
Crude cellulose (% DM)	Xsr \pm SD	33.96 \pm 3.72	39.57 \pm 1.01
	CV %	10.95	2.55
NFE (% DM)	Xsr \pm SD	33.05 \pm 2.27	22.34 \pm 1.08
	CV %	6.86	4.83
Calcium (% DM)	Xsr \pm SD	1.11 \pm 0.39	2.79 \pm 0.19
	CV %	34.90	6.98
Phosphorous (% DM)	Xsr \pm SD	0.38 \pm 0.09	0.55 \pm 0.05
	CV %	22.86	9.07
Magnesium (% DM)	Xsr \pm SD	0.21 \pm 0.04	0.31 \pm 0.03
	CV %	20.36	8.47
Iron (mg/kg)	Xsr \pm SD	358.4 \pm 81.11	1279 \pm 175.7
	CV %	22.63	13.74
Zinc (mg/kg)	Xsr \pm SD	17.63 \pm 1.00	18.08 \pm 1.21
	CV %	5.68	6.68
Manganese (mg/kg)	Xsr \pm SD	43.10 \pm 7.39	87.26 \pm 5.90
	CV %	17.14	6.76
Copper (mg/kg)	Xsr \pm SD	8.52 \pm 0.78	8.63 \pm 0.20
	CV %	9.10	2.29

* % DM – percentage of dry matter

By analyses content of hazardous and noxious substances in samples of hay from Fruška Gora, determined level was in the range according to regulations (Rule book, 02/90). Therefore, all hay samples cultivated in this region can be regarded safe for use as animal feed.

Table 2. Presence of toxic matters (mycotoxins, pesticides and heavy metals) in hay samples

	Mixed hay (n=8)	Lucerne hay (n=8)	Method deployed
<i>Mycotoxins</i>			
Aflatoxins (B1 + G1)	2.59±0.13 µg/kg	2.7±0.09 µg/kg	ELISA, IHM-03-007
<i>Metals and metalloids</i>			
Arsenic (As)	0.10 mg/kg	0.10 mg/kg	HGAAS, IHM-03-001
Mercury (Hg)	0.10 mg/kg	0.10 mg/kg	HGAAS, IHM-03-001
Cadmium (Cd)	0.05 mg/kg	0.05 mg/kg	GFAAS, IHM-03-001
Leads (Pb)	0.20 mg/kg	0.20 mg/kg	GFAAS, IHM-03-001
<i>Organochlorine pesticides</i>			
HCH (isomers alpha, delta & beta)	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002
Lindane	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002
Aldrine & dieldrine	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002
Heptachlor & heptachlor-peroxides	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002
DDT & derivates	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002
Endrine	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002
Endosulphane (isomers alpha, beta & sulphate)	0.010 mg/kg	0.010 mg/kg	GC-ECD, IHM-03-002

DISCUSSION

Sustainability of farming system under organic management may be increased by the introduction of Lucerne in crop rotation. Lucerne is a recognized as the most widely adapted agronomic crops, important and the cheapest source of protein rich forages of excellent amino acid composition and high digestibility, which is so valuable in economical animal husbandry. Beside that, this species is important for soil improving, especially as effective source of biological nitrogen fixation and it has important place in crop rotation. It is one of the few cultivated plants that can produce high levels of biomass with minimum inputs. It's a reason why Lucerne, besides an important role in conventional husbandry is getting a great role in sustainable agriculture and organic production (Annicchiarico *et al.*, 2006).

Based on analyses of chemical and botanical composition samples of mixed hay investigated in this study were classified into second quality hay. Since two plant species were predominant (*Dactylis glomerata* L. and *Poa pratensis* L.) production of 8.5 to 10.5 t/ha could be expected. Calculated crude protein content

of plants grown (according to nitrogen percentage) gives average yield of 861 to 1266 kg per ha.

Dairy cows with average milk yield of 5.000 kg milk animal⁻¹ year⁻¹ in organic farming, have demands of 115 kg of crude nitrogen which equals 718.75 kg of crude protein (Lund, 2003).

Mixed hay samples cultivated on one ha in region of Fruška Gora can therefore provide nutrients for breeding of 1.20 to 1.76 dairy cows, per ha. Bakker and Heerd (2005) have monitored forage quality on the grasslands in the Netherlands, during the period of 11 years after transition from conventional to organic farming. They have concluded that it remained sufficient for the production of 6000 kg milk animal⁻¹ year⁻¹. The vegetation showed considerable changes during the study period. The sandy pastures initially featured a strong dominance of *L. perenne*, which however declined dramatically from 90% to 20% cover during the study period. At the end of the study period six grass species occurred with similar cover percentages, namely, *Alopecurus pratensis*, *Dactylis glomerata*, *Elymus repens*, *H. lanatus*, *L. perenne* and *P. trivialis*. These findings are in accordance to our findings since we have found that *Dactylis glomerata* and *Poa pratensis* were the dominant species. On the other hand Korevaar (1986) found that on extensively, unfertilized grazed grassland due to low nitrogen availability, finds hard to reach the forage quality to feed a cow with a production of 5000 kg milk animal⁻¹ year⁻¹ properly. Based on our findings pastures and meadows of Fruška Gora, present a solid base for organic dairy farming.

Measured crude protein content of Lucerne hay was 16.32% which gives 1338 to 1371 kg of crude protein per ha of Lucerne hay. This amount of proteins can therefore provide demands of 1.86 to 1.91 dairy cows with milk production of 5.000 kg milk animal⁻¹ year⁻¹. This result is in compliance with the results of (Marković *et al.*, 2007a and Đukić *et al.*, 2007). The Lucerne hay is characterized by a high content of crude protein, well balanced with respect to amino acids. It is rich in vitamins, and various trace elements essential for normal growth and development of animals (Marković *et al.*, 2007a). Lucerne is the basic component in the feeding program for dairy cattle, as well as for beef cattle, horses, sheep and other classes of livestock. Beside that, rapid recovery after cutting, longevity and tolerance to environmental stress is important for stabile yield during all periods of exploitation. Also, symbiotic N₂ fixation in Lucerne eliminates the need for use of chemical N and adds a beneficial carryover effect in crop rotation.

In Serbia, Lucerne is the second most important forage crop after maize. It is grown on over 200 000 ha in pure stand, which is about 4% of total agricultural area in Serbia (Đukić *et al.*, 2007). Sustainable agriculture and organic production are an important part of research projects and agricultural development in Serbia, and the special role in those productions belongs to Lucerne. Lucerne is regarded as a highly nutritious animal feed and it is preferred to other forages in feeding ruminants. The demand arises because its primary nutritive values is based on rapid passage through the gastrointestinal tract, large amounts of soluble protein provided for rumen microorganisms for resynthesis of proteins, synthesis of B vitamins and stimulation of cellulose digestion, vitamin A, E and K or their precursor contents all of which are vital protective nutrients when Lucerne forages

are fed to dairy cattle. Lucerne has relatively large amounts of cell solutes and the lowest amount of cell walls in comparison with other forages (Tomić *et al.*, 2001).

The Lucerne hay samples were characterized by higher Ca-contents (2.79 ± 0.19), compared to mixed hay samples (1.11 ± 0.39). The contents of P were, however, similar to those of grasses. These findings are in accordance to the findings of Gruber *et al.* (1999). Content of trace elements in examined mixed and Lucerne hay samples did not differ significantly. Similar to these were the findings of Marković *et al.* (2007b).

The practical value of Lucerne is not restricted to its fodder qualities alone. It also performs other important economic and biological functions: it enriches the soil with nitrogen, is a good predecessor for many agricultural crops, serves as a desalinator crop, it's a good green-manure and nectar producing crop and reduces effect of water and wind erosion by binding the soil. Cultivation of Lucerne in crop rotation fields not only improves soil fertility, but also increases the yield of subsequent crops. All this traits make Lucerne essential in organic agriculture (Torricelli, 2006).

Organic farming concept is based on use of minimally 60% of roughage which originates from organically cultivated grasslands in the region of the farm. Production level of grasslands on Fruška Gora gives the possibility for breeding 1.20 to 1.91 dairy cows per ha of grassland, depending on hay type (mixed or Lucerne hay) and therefore can be a solid base for further development of organic dairy farming.

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Address for correspondence:
Dr Svetlana Grdović
Faculty of Veterinary Medicine
University of Belgrade
Bulevar oslobođenja 18,
11000 Belgrade, Serbia
E-mail: cecag@vet.bg.ac.rs

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ISPITIVANJE KVALITETA SENA SA FRUŠKE GORE U ORGANSKOJ PROIZVODNJI MLEKA

GRDOVIĆ SVETLANA, SAVIĆ MILA, JOVANOVIĆ S, POPOVIĆ-VRANJEŠ ANKA,
PETRUJKIĆ B i BOSANČIĆ D

SADRŽAJ

Kao rezultat povećanja tržišnih potreba za organskim proizvodima, naročito za mlekom, došlo je do intenziviranja organskog stočarstva u Srbiji. U ovom radu je ispitivan botanički i hemijski sastav dve vrste sena iz regiona Fruške Gore koja se koriste u organskoj proizvodnji mleka. U uzorcima mešanog sena, prisutne vrste iz familije *Poaceae* su na osnovu hranljive vrednosti klasifikovane u prvu klasu livadsko-pašnjačkih trava. Utvrđeno je prisustvo *Dactylis glomerata* L. i *Poa pratensis* L. Seno lucerke je u najvećem delu bilo sastavljeno od jedne vrste, *Medicago sativa* L. Određivan je sadržaj osnovnih hranljivih materija u mešovitom senu i senu lucerke: sirova vlaga, pepeo, proteini, mast i celuloza. Pored njih određivan je i sadržaj Ca, Mg, P, Cu, Fe, Mn i Zn. Utvrđeni nivo štetnih materija (mikotoksini, pesticidi i teški metali) bio je u propisanim granicama. Botaničkom analizom je utvrđeno da su u uzorcima bile zastupljene biljke koje su zadovoljavajuće hranljive vrednosti i daju velike prinose. Hemijskom analizom utvrđeni nivo proteina, celuloze, masti, makro i mikroelemenata može u potpunosti da zadovolji potrebe mlečnih krava u organskoj proizvodnji i predstavlja dobru osnovu za dalji razvoj organskog stočarstva.