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QUALITY OF SILAGE OF MIXED SUNCHOKE AND LUCERNE FORAGE

SUMMARY

The paper presents the chemical composition, nutritional and usable value of sunchoke (*Helianthus tuberosus* L.) and the possibility of using it for animal nutrition in fresh and canned form. Tests show that sunchoke cut in mid-June contains about 9.43% of crude protein, 2.49% of crude fat, 19.93% of crude cellulose, 50.50% of NFE (nitrogen-free extractives) and 17.65% of ash in the dry matter. Although lucerne biomass had a more favorable chemical composition (18.13% crude protein, 6.72% crude fat, 25.24% crude cellulose, 39.35% BEM and 10.56% ash), the benefits of sunchoke are in the more successful growing in less favorable natural, primarily soil conditions, the more suitable it is for ensiling and the longer it stays on one planted plot. Since it is predominantly an energy (carbohydrate) nutrient, the possibility of ensiling the green biomass of sunchoke in a mixture with 25, 50 and 75% fresh lucerne (25% dry matter) was investigated. The obtained results show that with the increase of lucerne participation, the nutritional value of silage increases, but the quality decreases. In addition to its role in conventional feed production, sunchoke can be an important plant in the system of organic production, production for industrial processing and for extensive cultivation in hunting grounds.

Keywords: sunchoke, lucerne, nutritional value, silage, quality.

INTRODUCTION

Sunchoke (*Helianthus tuberosus* L.) is a plant related to sunflower and potato, native to North America. It thrives in continental and warm climates, on wetter loose soils, although it tolerates drought well. In Montenegro, sunchoke is not grown in organized production, and according to its characteristics, it could be a very important fodder plant for extensive livestock production in less favorable natural conditions of rural areas. Due to its pronounced resistance to diseases and pests, it can play an important role in organic livestock, using the

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underground (tubers) and aboveground part of the plant, fresh or as silage. Also, sunchoke can be grown in an organized way due to the production of tubers for industrial processing, in order to obtain an important medical item of inulin. This polysaccharide contains several plant species, but this content (quantity) is cost-effective for industrial extraction, of the plants known to us only in sunchoke and chicory *Chichorium intibus* (Đorđević and Dinić 2007). Sunchoke can also be grown in more orderly hunting grounds for game (Đorđević *et al.*, 2009; 2010a, b). Its production is quite economical because it has no pronounced requirements in plant nutrients, and once planted, it remains for many years on that plot thanks to vegetative self-reproduction. Recognizing the importance of the genetic potential of sunchoke, more and more work is being done in the field of inventory, collecting and selection. Thus, more than 150 autochthonous varieties of *Helianthus tuberosus* are kept at the Institute of Field and Vegetable Crops in Novi Sad, some of which are from Montenegro (Radovanović, 2013).

Basic characteristics of the chemical composition of sunchoke

The potential importance of sunchoke as a species for animal feed lies in the fact that both the aboveground plant mass and the underground part-tubers can be used efficiently, with high yields and modest agricultural techniques. Yields of aboveground mass of sunchoke are 25-50 t/ha and tuber yields 30-60 t/ha. Sunchoke root (tubers) contains about 80% water and in dry matter about 15% carbohydrates and 1-2% crude protein, with 30-40% nitrogenous substances of amide form. The amount of crude cellulose is about 1% and fat about 0.2%. The main carbohydrate component of the dry matter of sunchoke root is inulin, a linear polymer of D-fructose molecules). The amount of iron in sunchoke root is about three times higher than in potatoes, and it also has relatively high amounts of selenium (about 50 µg / 100 g). It is also a rich source of B complex vitamins, C and β carotene. In previous studies, it has been proven that inulin shows probiotic properties, participates in better mineral absorption and prevention of some serious diseases.

Ways of using sunchoke in animal nutrition

Klimmer (1926) states that sunchoke can be mowed twice a year, and Zdanovski (1945) states the possibility of sunchoke ensiling, at the stage when the lower leaves begin to wither. Milošević (1971) and Đorđević (1975) point out that the above-ground mass of sunchoke should be used only in autumn, just before the first frosts, because earlier mowing significantly reduces tuber yields. Zafren (1977) recommends mowing sunchoke for silage in the pre-flowering phase, in order to increase the digestibility of dry matter. In any case, the earlier use of aboveground mass of sunchoke has an extremely negative effect on root yield, and it is difficult to reconcile these two ways of using this plant species (for ruminant nutrition and industrial processing). Growing sunchoke for green mass within the conveyor production of fresh fodder makes sense only if it is the only product (no tuber yield is planned). In this case, thanks to regeneration, two to three cuttings can be obtained from sunchoke, depending on the amount of precipitation or the application of irrigation, similar to sorghum or Sudan grass.

One of the significant advantages mentioned by users in the field is the lower sensitivity of sunchoke to lower temperatures, which is why it can be grown at higher altitudes, with solid yields of green (aboveground) mass.

Sunchoke root is used in a similar way as potatoes, except that no heat treatment is required for non-ruminants since it does not contain solanine (Đorđević et al., 1996). Sunchoke tubers have a thin skin and cannot be stored (trapped) or used for a long time when taken out of the ground. In extensive cattle breeding, sunchoke is used by releasing pigs into fields with this plant, and digging out tubers. At the same time, there are always enough smaller tubers left from which young plants will develop in the next season. Due to the stated characteristics of sunchoke, it could be an important plant species for food production in organic livestock (Đorđević et al., 2014).

MATERIAL AND METHODS

One of the most important possibilities of using the above-ground part of sunchoke for feeding domestic animals is in the form of silage. Since the aboveground part is primarily an energy nutrient, especially in the later stages of development, it is recommended to combine it with protein nutrients, ie legumes. Bearing in mind that lucerne (*Medicago sativa*) is a high-protein fodder plant, compared to sunchoke, it is less suitable for ensiling, this research included the ensiling of mixed fodder of these plants in different proportions, as follows:

Variants	Sunchoke (%)	Lucerne (%)
I	100	0
II	75	25
III	50	50
IV	25	75
V	0	100

Analyses of the initial material and silage samples were performed according to standard laboratory methods at the Institute of Animal Husbandry, Faculty of Agriculture in Zemun. The quality of silage was determined by DLG methodology.

RESULTS AND DISCUSSION

The results of testing the chemical composition of the starting material (ensiling biomass) of sunchoke and lucerne are given in Table 1.

Table 1. Chemical composition of starting materijal sunchoke and lucerne (%)

Starting matrijal	DM	Cr.prot.	Cr. lipid	Cr. fiber	NFE	Ach
Sunchoke	13.63	9.43	2.49	19.93	50.50	17.65
Lucerne	25.11	18.13	6.72	25.24	39.35	10.56

Performed analyses on the chemical composition of the starting material (green mass of sunchoke) showed that sunchoke cut in mid-June contains in dry matter (13.63%) 9.43% of crude protein, 2.49% of crude fat, 19.93% of crude cellulose, 50.50% NFE and 7.65% ash. When compared, lucerne dry matter (25.11%) contained more crude protein (18.13%), crude fat (6.72%), crude

cellulose (25.24%), and less BEM (39.35%) and ash (10.56%). Chemical composition and quality of silage mix by tested variants is presented in Table 2.

Table 2. Chemical composition and quality of silage sunchoke and lucerne (%)

Parameter	Silage mix of sunchoke and lucerne, ratio in %				
	I 100:0	II 75:25	III 50:50	IV 25:75	V 0:100
DM	11.54	13.80	16.57	18.50	21.65
Crude protein	10.12	10.59	12.44	14.94	17.47
Crude lipid	2.77	3.45	5.66	5.84	6.35
Crude fiber	21.24	21.87	22.94	22.78	24.94
NFE	49.62	48.57	43.05	42.28	40.08
Ach	16.25	15.52	15.91	14.13	11.16
Lactic acid	4.70	3.58	4.06	2.55	3.34
Acetic acid	2.51	2.68	3.01	3.39	1.83
Butyric acid	0.19	0.38	0.52	0.86	1.32
Quality by DLG	II	II	III	IV	IV

The obtained results of chemical analyses of silage composed of sunchoke and lucerne, show that lucerne participation increment also increase pH value of silage and the content of butyric acid, while the production of lactic acid decreases. At the same time, the quality of the silage, evaluated by the DLG method, decreases from class II (100% sunchoke) to class III (75:25 and 50:50% - sunchoke: lucerne) and class IV (25% sunchoke and 75% lucerne). Therefore, it is recommended to maximize the share of fresh lucerne in the mixture with sunchoke up to 50% or pre-drying lucerne (Đorđević *et al.* 1996).

The disadvantage of this silage mixture is the fact that the starting material of both plant species contain larger amounts of moisture, which indicates the need to pass the initial material (lucerne), or add some dry nutrients (when ensiling sunchoke in pure form). In the research of Adamović *et al.* (2014) the moisture content in the aboveground mass of sunchoke ranged from 80.71 to 67.41% in the period June-October. According to Đorđević and Dinić (2003), quality silage can be prepared only from materials with less than 70% moisture, otherwise it must be tested or combined with drier nutrients. According to these authors, in a material with more than 80% moisture, butyric fermentation cannot be stopped even when using chemical preservatives. If, for the above reasons, sunchoke was ensiled in October, with a favorable moisture content (<70%), there would be a decline in the quality and yield of silage.

CONCLUSIONS

Based on the results from our study and reviews of previous research, it can be concluded that sunchoke in the changed continental climate can be an important fodder plant for animal nutrition in conventional and organic livestock, using underground organs (tubers) and the aboveground part of the plant fresh or

ensiled. Also, this plant can be successfully used in the hunting economy, when establishing perennial crops, for feeding and sheltering wild animals.

Beside deficiency in chemical composition (nutritional value) compared to lucerne, sunchoke has advantages due to its lower agrotechnical requirements, more economical production and better adaptability to less favorable natural conditions.

In addition to its role in animal nutrition, sunchoke is also important as a plant for industrial processing, for the extraction of polysaccharide inulin.

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