RESEARCH ON CHEMICAL COMPOSITION OF ALFALFA HAY OBTAINED IN DIFFERENT PRODUCTION SYSTEMS (CONVENTIONAL AND ORGANIC)

Nadia Mirela Aioanei[1*], I.M. Pop[1]

[1]*University of Agricultural Sciences and Veterinary Medicine Iasi, Romania*

Abstract

The aim of this paper was a comparative analysis of the chemical composition determined for 10 samples of alfalfa hay, derived from two farms in the North-East part of Romania, with different production systems (conventional and organic). The research focused on determining the gross chemical composition (content of dry matter, crude ash, crude protein, crude fat, crude fiber, ADF, NDF and SEN) using Weende scheme and mineral content (Ca and P) by spectrophotometric method. In order to determine the chemical composition, the guidelines were standards like: ISO 6496:2001, ISO 6498:2001, EN ISO 6869:2001, ISO 6492:2001, EN ISO 6865:2002. Statistical analysis, revealed significant differences between the mean values calculated for alfalfa hay samples derived from conventional system compared with the ecological one for crude ash content (8.69±0.25% Ash vs. 6.75±0.28% Ash) and calcium (1.500±0.037% Ca vs. 1.224±0.040% Ca); distinctly significant for crude fiber content (32.28±1.03% CF vs. 27.67±0.67% CF) and nitrogen free extract substances (40.88±1.54% NFE vs. 34.40±1.16% NFE); significant for crude protein content (16.40±0.18% CP vs. 15.19 ± 0.45% CP) and acid detergent fiber (32.49 ± 0.76% ADF vs. 29.66 ± 0.82% ADF). For dry matter, organic matter, crude fat, NDF and phosphorus content, the differences were insignificant.

Key words: organic feed, alfalfa hay, chemical composition, calcium

INTRODUCTION

Alfalfa (*Medicago sativa L.*) is the most valuable plant grown for hay and occupies a particularly important place in cattle feed. The main factors influencing the chemical composition of alfalfa hay are growing stage at harvest, drying method, storage mode [10] and operating system.

Alfalfa is a legume commonly used in rotation with other crops (eg. cereals) to replenish soil organic nitrogen reserves due to the symbiotic relationship of the plant with nitrogen fixing bacteria *Sinorhizobium meliloti* [12].

The literature provides a wide range of data on the chemical composition of alfalfa hay obtained in the conventional sistem, statement which can not be sustained in organic alfalfa crops, where data are practically nonexistent.

Need to analyze the chemical composition of alfalfa hay from organic production systems, it is desirable precisely because no data in this regard.

MATERIAL AND METHOD

In order to achieve the objective a total of 10 samples of alfalfa hay were analyzed, second sew, in accordance with in force standards and legislation [20].

Half of the samples were taken from a conventional production profile unit of Iaşi county, and the other half from a specialized in organic production unit in Botoşani county.

Samples were transported to the laboratory in polyethylene bags, in order to prepare them for analysis.

Samples were subjected to drying processes, shredding and grinding up to 1mm diameter in accordance with the in force standard [22], in order to unify them and prepare for laboratory determinations.

*Corresponding author: nadiamirela@yahoo.com
The manuscript was received: 25.02.2013
Accepted for publication: 15.10.2013

Alfalfa samples were analyzed for the dry matter content (DM), crude ash (Ash), crude protein (CP), crude fat (EE), crude fiber (CF), neutral detergent fiber (NDF) and acid detergent fiber (ADF), following the required standards of analytical methods [23, 16, 18, 24, 21, 19, 17]. Nitrogen free extract (NFE) was calculated bz the following formula:

$$\% \text{ NFE} = \text{OM} - (\text{CP } \% + \text{EE}\% + \text{CF}\%) \quad [1]$$

Mineral content of the samples was evidence by determining the concentration of calcium (Ca) and phosphorus (P).

In order to determine the mineral content, atomic absorption spectrophotometry method was used; SHIMADZU spectrophotometer UVmini 1240, was set at a wavelength of λ = 422.7 nm for calcium concentration respectivly λ = 430 nm for the phosphorus concentration, the comparison being made with reference solution.

Expression of the results was done on DM basis for all items resulting from laboratory analysis.

Statistical processing of the obtained values was performed by calculating the location and variation statistical estimators (arithmetic mean ($\overline{X}$), standard deviation (s), standard deviation of the mean $s_{\overline{x}}$ and coefficient of variation (V%)). In order to determine the statistical significance of differences between calculated mean values FISHER test was used.

RESULTS AND DISCUSSIONS

The chemical composition of alfalfa hay samples taken from the two production systems (conventional and organic) with the significance of the differences (calculated value and table value for $\hat{F}$) average value calculated separately for each analyzed element, are presented in Table 1.

Mean results from analyzes for DM content of alfalfa hay was within the range found in the literature from 83% [11, 14] to 93.2% [8], for samples from the conventional system - 91.11% DM, while the samples from organic system containing 93.69% DM, stood slightly above the upper limit of the range mentioned above. The difference between the average values for this parameter is not statistically significant.

Results obtained for crude ash content of alfalfa hay, average values were within the range found in the literature of 8.1% [4] and 11% [11, 14], with values of 6.75% for samples derived from the conventional system and 8.69% for samples derived the organic one; the difference between the average values for this parameter is very significant statistically speaking.

Values resulting from analyzes performed for organic matter content of alfalfa hay were within the range found in the literature of 83% [13] to 90.7% [10], with values of 84.35% for samples derived from the conventional system and 85% for samples from the ecological one; the difference between the average values for this parameter is not statistically significant.

The 12.7% CP [4] and 25.4% CP [9] range, found in the literature includes average values resulting from the research for crude protein content of alfalfa hay, for samples from the organic system (15.19%) and those taken from the conventional one (16.40%); the difference between the average values for this parameter is significant, statistically speaking.

Mean values resulting from analyzes for crude fat content of alfalfa hay were within the range found in the literature of 0.9% [4] and 3% [7], with values of 1.28% for samples derived from conventional system and 1.26% for samples collected from the ecological one; difference between the results for this parameter is not significant in statistical terms.

Results for crude fiber content of alfalfa hay, were within the range found in the literature from 23% F [7, 2] to 32.28% [5], with values of 32.28% for samples taken from the conventional system and 27.67% for samples from the organic one; the difference between the average values for this parameter is distinctly significant statistically speaking.

Regarding nitrogen free extract content of alfalfa hay, mean results are 40.88% for the organic samples and 34.4% for the

conventional samples; the difference between the average values for this parameter is distinctly significant, statistically speaking.

The results of the research for neutral detergent fiber content of alfalfa hay have average values falling within the range found in the literature from 30% NDF [9] to 58.9% [4] which are 45.18% for the organic samples and 44.19% for the conventional samples; the difference between the average values for this parameter is not statistically significant.

Table 1 Chemical composition of alfalfa hay derived from two different production systems, conventional and organic

SPECIFICATION		n	$\bar{X} \pm s_{\bar{X}}$	s	V%	Range		FISHER Test
						Min	Max	
DM%[1]	Conv.	5	91.11±1.73	3.87	4.25	85.23	95.53	$\hat{F}$ =1.06 < $F_{0.5}$= 5.32
	Eco.	5	93.69±1.81	4.06	4.33	88.75	97.29	
% DM								
Ash[2]	Conv.	5	6.75±0.28	0.61	9.09	6.18	7.54	$\hat{F}$ =27.73> $F_{0.01}$= 25.42
	Eco.	5	8.69±0.25	0.55	6.30	7.87	9.25	
OM[3]	Conv.	5	84.35±1.73	3.87	4.58	79.01	89.35	$\hat{F}$ = 0.066 < $F_{0.5}$= 238.9
	Eco.	5	85.00±1.81	4.05	4.76	79.50	88.56	
CP[4]	Conv.	5	16.40± 0.18	0.40	2.46	16.02	17.01	$\hat{F}$ = 6.18 > $F_{0.5}$= 5.32
	Eco.	5	15.19±0.45	1.00	6.61	13.98	16.53	
EE[5]	Conv.	5	1.28±0.09	0.19	15.04	1.00	1.50	$\hat{F}$ = 0.013 < $F_{0.5}$= 238.9
	Eco.	5	1.26±0.11	0.24	19.37	1.00	1.56	
CF[6]	Conv.	5	32.28±1.03	2.31	7.15	29.8	35.24	$\hat{F}$ =14.03 > $F_{0.1}$= 11.26
	Eco.	5	27.67±0.67	1.49	5.39	25.73	29.30	
NFE[7]	Conv.	5	34.40± 1.16	2.60	7.55	31.87	38.75	$\hat{F}$ =11.29 > $F_{0.1}$= 11.26
	Eco.	5	40.88±1.54	3.43	1.54	3.43	8.40	
NDF[8]	Conv.	5	44.19±0.86	1.91	4.33	41.67	46.23	$\hat{F}$ = 0.509 < $F_{0.5}$= 238.9
	Eco.	5	45.18±1.09	2.44	5.40	41.08	47.22	
ADF[9]	Conv.	5	32.49±0.76	1.70	5.22	30.56	34.78	$\hat{F}$ =6.46 > $F_{0.5}$= 5.32
	Eco.	5	29.66±0.82	1.83	6.16	27.89	32.51	
Ca	Conv.	5	1.224±0.040	0.079	6.424	1.092	1.277	$\hat{F}$ =29.64 > $F_{0.01}$= 25.42
	Eco.	5	1.500±0.037	0.083	5.503	1.398	1.625	
P	Conv.	5	0.207±0.008	0.017	8.311	0.193	0.233	$\hat{F}$ = 0.22 < $F_{0.5}$= 5.32
	Eco.	5	0.202±0.006	0.014	6.706	0.184	0.217	

[1]DM%= dry matter; [2]Ash= crude ash; [3]OM= organic matter; [4]CP= crude protein; [5]EE= ether extract; [6]CF= crude fiber; [7]NFE= nitrogen free extract; [8]NDF=neutral detergent fiber; [9]ADF= acid detergent fiber;

Detergent fiber content of alfalfa hay, mean results of the research, falls within the range found in the literature of 24% [9] and 45.9% [4], with values of 29.66% for the organic system samples and 32.49% for the conventional one; the difference between the average values for this parameter is distinctly significant, statistically speaking.

Regarding mineral content of alfalfa hay as the resulting values from samples taken from the ecological system and the conventional one were within the limits of variation found in the literature.

Thus, the calcium content limit of variation of 0.19% [3] and 1.5% [7], with average values resulting from the research of 1.22% for samples from the conventional system and 1.5% a for samples from the ecological one; the difference between the average values for this parameter is very significant, statistically speaking.

For phosphorus content of alfalfa hay, the variation limit is from 0.21% [6] to 0.31% [4], with average values resulting from the research of 0.207% for conventional analyzed samples and 0.202% for samples taken from the ecological system; the difference between the average values for this parameter is not statistically significant.

The chemical composition of alfalfa hay samples taken from two different production systems, conventional and organic, falls mostly within the literature range.

Differences with statistical significance between the mean values calculated for Ash, CP, CF, NFE and ADF can be considered as the result of influence of agrotechnical specific factors of the two production systems, and the different nature of fertilization and fertilizing products. Alfalfa crop fertilization in conventional production system, was in spring with a NPK 20-20-0 complex, 150 kg/ha; phosphorus plays an important role in nitrogen assimilation [15].

For the organic production system, fertilization was carried out only with manure derived from cattle, applied on the soil surface in winter, prior seeding, in a quantity of 40 t / ha.

Another possible explanation regarding the differences, may be the influence of a number of factors, independent of operating system type, conventional or organic, such as growth phase at the time of harvesting, harvesting technology, post harvest handling mode or the storage conditions.

The difference in concentration of phosphorus in the samples taken from the two production systems is insignificant and can be said that has not been affected by the applience of NPK 20-20-0 complex.

Regarding the calcium concentration of the analyzed samples the difference between average values for samples analyzed from the conventional production system and the organic one, can be explained by the lack of calcium fertiliyer application for the conventional system and the existence of calcium in manure applied to the soil surface before seeding for the organic farm.

CONCLUSIONS

The analizes performed on alfalfa hay samples taken from the two production systems, conventional and organic permit us to conclude by saying that:

- chemical fertilization with NPK 20-20-0 complex, influence protein content, so a larger amount was found in the samples from the conventional system;
- phosphorus content was not influenced by complex NPK 20-20-0 aplication;
- concentration of calcium and therefore gross amount of ash was higher in samples from organic production system;
- many factors that can influence the chemical composition are both dependent and independent on the production system, conventional and organic, and therefore further research regarding differences in chemical composition of fodder from the two systems is appropriate and in order to increase the accuracy of the results, influence factors should be limited as much as possible by organizing researchers in well-controlled environments.

ACKNOWLEDGEMENTS

The studies were conducted under POSDRU 77222 project, therefore the authors would like to express their thanks for the financial support.

REFERENCES

[1] Avarvarei T., 1999: Nutriția animalelor domestice, Edit. Ion Ionescu de la Brad. Iaşi.
[2] Balliette J., Torrel R., 1998: Alfalfa for beef cows, University of Nevada Second edition; Fact Sheet 93-23.
[3] Burlacu Gh., Cavache A., Burlacu R., 2002: Potențialul productiv al nutreţurilor şi utilizarea lor. Editura CERES. Bucureşti.
[4] Dien B.S., Hans-Joachim G., Jung K. P., Vogel M. D., Casler J.F.S., Lamb.L. I., Robert B., Mitchell G. S., 2006: Chemical composition and response to dilute-acid pretreatment and enzymatic saccharification of alfalfa, reed canarygrass, and switchgrass, Biomass and Bioenergy 30 (2006) 880–891.
[5] Donosă R.E., 2011: The nutritive value of alfalfa hay in some dairy cow farms from Moţca village (Iaşi county), Lucrări Ştiinţifice - vol. 56: 191-194, Seria Zootehnie.
[6] Drake D., Nader G., Forero L., 2002: Feeding rice straw to cattle, publication 8079.
[7] Ewing W. N., 1998: The FEEDS Directory Commodity Products, ISBN10: 1899043012.
[8] Kamalak A., Canbolat O., Erol A., Kilinc C., Kizilsimsek M., Ozkan C. O., and Ozkose E., 2005: Effect of variety on chemical composition. in vitro gas production, metobolizable energy and organic matter digestibility of alfalfa hays, Livestock Research for Rural Development 17 (7).
[9] Martin N. P., Mertens D. R., and Weimer P. J., 2004: Alfalfa: hay, haylage, baleage, and other

novel products. Alfalfa and Forage Conference 23-24 February 2004.
[10] Pop I.M., Halga P.. Teona A.. 2006: Nutriția și alimentația animalelor. Edit. Tipo Moldova.
[11] Preston R.L., 2010: Wat's the feed composition value of that cattle feed?, Beef Magazine.
[12] Santos R., Herouart D., Sigaud S., et al., 2001: Oxidative burst in alfalfa – Sinorhizobium meliloti symbiotic interaction Mol. Plant-Microbe Interact. V. 14, nr 3, p. 86–89.
[13] Sauvant D., Jean-Marc P. and Gilles T., 2004: Tables of comosition and nutritional value of feed materials. Institute de la Recherche Agronomique (INRA), Paris.
[14] Stanton T.L., LeValley S., 2010 – Feed composition for cattle and sheep, Livestock Series, Fact Sheet No 11615.
[15] Vîntu V. (coord.), Moisuc A., Motcă Gh.. Rotar I., 2004: Cultura pajiștilor și a plantelor furajere. Ed. "Ion Ionescu de la Brad" Iași.
[16] *** SR EN ISO 2171:2010 Cereale, leguminoase și produse derivate. Determinarea conținutului de cenușă prin calcinare.
[17] *** SR EN ISO 13906:2008 Nutrețuri. Determinarea conținutului în fibre a detergentului acid (ADF) și în lignină sulfurică (ADL).
[18] *** SR EN ISO 20483:2007 Cereale și leguminoase. Determinarea conținutului de azot și calculul conținutului de proteină brută - metoda Kjeldhal.
[19] *** SR EN ISO 16472:2006 Nutrețuri. Determinarea conținutului în fibre prin tratare cu amilază și detergent neutru.
[20] *** SR EN ISO 6497:2005 Nutrețuri. Eșantionare.
[21] *** SR EN ISO 6865:2002 Nutrețuri. Determinarea conținutului de fibră brută. Metoda cu filtrare intermediară, calculul conținutului de proteină brută - metoda Kjeldhal.
[22] *** SR ISO 6498:2001 Nutrețuri. Pregătirea probelor pentru analiză .
[23] *** SR ISO 6496:2001 Nutrețuri. Determinarea conținutului de umiditate și de alte substanțe volatile.
[24] *** SR ISO 6492:2001 Nutrețuri. Determinarea conținutului de grăsime.