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The influence of zeolite addition on quality of fresh lucerne silage

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Abstract: The influence of natural zeolite addition on chemical composition and quality of silages was investigated. Lucerne was ensiled with and without technologically processed natural zeolite (Min-A-Zel, product of ITNMS, Belgrade) in the amounts of 80, 400 and 2000 g per 100 kg of fresh lucerne (with approximately 250 g/kg dry matter). Ensiling was done immediately after harvesting or after 24 hours (two factorial experiment 4 × 2). Second part of the experiment (after 24 hours) was done to investigate the additional contamination of lucerne with aerial microorganisms.

The results of the investigations show that addition of the technologically processed natural zeolite while lucerne ensiling enhances the fermentation intensity and results in the increase in acetic acid production with the lower pH values and more favourable ratio of lactic to total acids. The influence of mentioned doses of zeolite on chemical composition was less pronounced and is mostly relative. The only real changes were the increase of dry matter content and of the mineral content.

According to DLG method the control silage was ranked as III quality class, silages with lowest and medium doses of zeolite in II quality class and silage with maximal dose of zeolite in I quality class.

Key words: lucerne, silage, zeolite.

Introduction

Lucerne is the most important forage culture in Serbia after maize. It has high nutritive value, is rich in protein, calcium and carotene, produces high yields during the long lifespan and can be used in many ways as fresh, silage, haylage, dehydrated meal or protein concentrate produced from lucerne juice (Mejakić et al. 1997; Đorđević et al. 2001;).

The most economical way of utilizing roughage, including lucerne, is as a fresh green plant. However, lucerne is not very suitable for pasture and has certain harmful compounds, which may induce bloat in ruminants. This is the reason why it use in conserved form, as silage or haylage, is preferred (Grubić et al. 2001; Đorđević et al. 2002).

The high buffering value, low sugar content and significant content of moisture cause problems in lucerne ensiling, that being the reason why certain procedures or conservants are used (Dinić et al., 1998). One of possibilities to improve fermentation conditions is wilting of the green mass, which means the increase of dry matter content above 35% to inactivate most plant and bacterial enzymes. Along with that procedure the higher dry matter in dairy cow feeding is achieved which is important for high milk yield. With the natural level of moisture lucerne is successfully ensiled with the addition of carbohydrate or chemical additives, biological preparations or combined with easily ensiled plants (Koljajić et al., 1997; Dinić et al. 2004).

In our country the investigation of mineral adsorbents – zeolites as additive in silage production is continuing during the past few years (Adamović et al., 2001, 2005; Bočarov-Stančić et al. 2005; Đorđević et al., 2003-a,b; Koljajić et al., 2003). It is well known that due to their high adsorptive ability zeolites were first used to bind ammonia in intensive agriculture. In practice they are used more and more as additives in complete concentrate mixtures for domestic animals, as prevention to possible mycotoxicosis.

The aim of this work was to investigate the influence of natural zeolite used in various doses, on chemical composition and quality of lucerne silages. It was assumed that zeolite adding might have influence not only on mould activity and presence of mycotoxins but also on fermentation intensity in the ensiled material.

Materials and methods

Natural technologically processed zeolite was used as silage additive (Min-A-Zel, product of ITNMS – Belgrade). The trial was performed as two-factorial (Table 1), where first factor (A) was zeolite dose (a_1 = 0.00 g/100 kg fresh lucerne; a_2 = 80 g/100 kg fresh lucerne; a_3 = 400 g/100 kg fresh lucerne and a_4 = 2000 g/100 kg fresh lucerne) and the second factor was ensiling time (b_1 = immediately after cutting and b_2 = 24 hours after cutting). Lucerne was ensiled 24 hours after cutting in order to obtain increased contamination of various aerial microorganisms.

Table 1. Experimental plan

B-Time of ensiling	A – Zeolite dose, g/100 kg lucerne			
	a_1	a_2	a_3	a_4
b_1 - immediately after cutting	0	80	400	2000
b_2 - 24 hours after cutting	0	80	400	2000

Lucerne of the cultivar NS Medijana ZMS V, of the second cut on the beginning of flowering was used. Silages were prepared in experimental siloses with volume of 60 dm^3. The average volumetric mass of 600 g/dm^3 was achieved by compression. After compression the surface of the mass was covered with plastic foil and secured with pebbles and than hermetically sealed. The siloses were opened after 45 days and samples for chemical analyses were taken. All silages had pleasant smell and surface layer of 2-3.5 cm was oxidized. Chemical analyses were done by proximate analysis (AOAC, 1984), the content of lactic, acetic and butyric acid was investigated by Wiegner's method and pH values in silage water extract on pH-meter (MA-5722). The evaluation of silages was done according to DLG system (1997). Statistical analysis was done by ANOVA, using *Tukey HSD* test by STATISTICA (data analysis software system), version 6.

Results and discussion

Due to the inclusion of mineral adsorbent Min-A-Zel the gradual increase of dry matter and ash content was observed (Table 2). The significant changes in the content of certain substances are of relative nature, the result of the increase in the amount of ash. The decrease of NFE content can be explained with its more intensive use in fermentation and production of lactic acid.

Lucerne silages ensiled 24 hours after cutting had significantly more dry matter while the contents other components were not much changed. The higher amount of dry matter was result of the fact that lucerne stayed on the field for 24 hours.

Table 2. Chemical composition of silages, g/kg SM

Parameters	Treatments					
	A				B	
	a_1	a_2	a_3	a_4	b_1	b_2
Dry matter, g/kg	254.10 c	269.00 b	265.40 b	274.20 a	251.80 b	279.60 a
Crude protein	187.11 a	182.06 b	183.84 b	182.38 b	185,10 a	182.59 a
Crude lipids	70.82 a	73.18 a	77.06 a	70.42 a	71,50 a	74.24 a
Crude fibre	249.17 a	251.99 a	253.55 a	251.62 a	250,23 a	252.93 a
NFE	362.26 a	362.06 a	353.52 ab	345.10 b	358,02 a	353.45 a
Ash	130.64 b	130.71 b	132.03 b	150.48 a	135,14 a	136.78 a

[a,b,c] Values in the same row with different letter are significantly different ($P<0.05$)

The decrease of pH values in silages with zeolite added is the result of the more intensive lactic acid type fermentation and higher content of lactic acid (Table 3). With the increase of zeolite dose the amount of lactic acid was significantly increased. Adamović et al. (2001) ensiled whole maize plant with the zeolite added (0.2%) and in the optimal conditions they discovered the increase of lactic acid production from 73,36 to 82,20%, while in less favourable conditions it was from 49,52 to 75,40%. One of explanation for this is in the fact that zeolite is not only adsorbs mycotoxin and gas but also water. Lactic acid bacteria are more tolerant to the increase of osmotic pressure compared to others and this is why they tend to produce more lactic acid in silages with higher dry matter content (McDonald, 1981). Also, in treatments with zeolite the other favourable conditions for their activity occur, first of all considering the mycotoxin adsorption with the Min-A-Zel (Adamović et al., 2001). Contrary to that, the amount of bound and total acetic acid was not influenced with the addition of zeolite. This confirms that conditions after the addition of zeolite were more favourable for homofermentative lactic acid bacteria. Butyric acid was not determined in all of the experimental silages.

Table 3. Parameters of biochemical changes in silages, g/kg dm

Parameters	Treatments					
	A				B	
	a_1	a_2	a_3	a_4	b_1	b_2
pH	5.46 a	5.38 b	5.30 c	5.19 d	5.27 b	5.38 a
Lactic acid	128.76 c	144.48 b	158.08 a	161.40 a	155.54 a	140.82 b
Acetic acid:						
Free	31.11 a	26.56 a	27.30 a	26.10 a	30.57 a	24.97 b
Bound	77.91 a	52.37 b	55.54 b	46.76 c	55.93 b	60.36 a
Total	109.02 a	78.93 b	82.84 b	72.86 b	86.50 a	85.33 a
Butyric acid	0.00	0.00	0.00	0.00	0.00	0.00

[a,b,c,d] Values in the same row with different letter are significantly different ($P<0.05$)

The significantly higher pH values in silages made later are the result of the less positive conditions for lactic acid bacteria, as a result of sugar utilization within the plant cells during the discontinued metabolism or because of contamination with aerobic microorganisms and their activity.

In all silages the lactic acid was dominant compared to total acid content (Table 4). With the increased dose of zeolite the amount of lactic acid was increased not only in absolute but also in relative value while amount of acetic acid decreased.

Using DLG method for silage evaluation the values given in the Table 4. were obtained. There were no differences influenced with the time of ensiling.

Table 4. Relative amounts of acids and silage quality

Parameters	Treatments					
	A				B	
	a_1	a_2	a_3	a_4	b_1	b_2
Lactic/total acids	0.54	0.65	0.66	0.69	0.64	0.62
Acetic/total acids	0.46	0.35	0.34	0.31	0.36	0.38
Butyric/total acids	0.00	0.00	0.00	0.00	0.00	0.00
Number of points	35	42	42	44	44	44
Quality class by DLG method	III	II	II	I	I	I

Conclusion

The results of investigations done show that zeolite addition in lucerne ensiling contributes to the fermentation intensification and production of lactic acid, resulting in more advantageous ratio of lactic acid with other acids. The influence of zeolite addition on proximate chemical composition was less pronounced and is mostly relative. The only real changes were the increase of dry matter and ash content.

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References

Adamović, M., Nešić, S, Stoićeviš, Lj., Tomašević-Čanović, M. (2001): Uticaj organski modifikovanog mineralnog adsorbenta mikotoksina "Minazel Plus" na kvalitet silaže biljke kukuruza. Arhiv za poljoprivredne nauke, 62, 220: 317-324.

Adamović, M., Bočarov-Stančić-A., Đorđević, N., Daković, A., Adamović, I. (2005): Mycotoxins in the silage-causes of creating, aftermath and protection from acting. Zbornik Matice srpske, No 108, 51-57.

AOAC (1984): Official methods of analysis. 14th ed. Association of Official Analytical Chemists, Washington, DC.

Bočarov-Stančić, A., Adamović, M., Đorđević, N. (2005): Mycopopulations of alfalfa silage with particular rewiev on toxigenic *fusarium* ssp. Zbornik Matice srpske, No 108, 59-67.

Dinić, B., Koljajić, V., Đorđević, N., Lazarević, D., Terzić, D. (1998): Pogodnost krmnih biljaka za siliranje. Savremena Poljoprivreda, Br. 1-2, str. 154-162.

Dinić, B., Đorđević, N., Ignjatović, S., Sokolović, D. (2004): Savremeni trendovi u tehnologiji siliranja. X simpozijum o krmnom bilju Srbije i Crne Gore sa međunarodnim učešćem. Acta Agriculturae Serbica. 9, 17: 553-564.

DLG (1997): DLG-Schlüssel zur Beurteilung der Gärqualität von Grünfuttersilagen auf der Basis der chemischen Untersuchung. Frankfurt a.M.: Deutsche. Landwirtschafts - Gesellschaft. Available at:http://www.futtermittel.net/pdf/grobfutterbewertung.pdf

Đorđević, N., Koljajić, V., Dinić, B., Grubić, G. (2001): Postupci konzervisanja i efekti korišćenja lucerke. Arhiv za poljoprivredne nauke, 62, 220, 285-292.

Đorđević, N., Koljajić, V., Grubić, G., Adamović, M., Glamočić, D. (2002): Silaža lucerke u ishrani krava. XVI savetovanje agronoma, veterinara i tehnologa. INI PKB Agroekonomik, Beograd. Zbornik naučnih radova 2002. Vol. 8. Br. 1. Str. 329-340.

Đorđević, N., Grubić, G., Adamović, M., Dinić, B., Lazarević, D. (2003-a): Intensity of biochemical changes in lucerne silages with addition of zeolite and formic acid. 11th International symposium "Forage conservation. 9th-11th September 2003. Nitra, Slovak Republic. 132-133.

Đorđević, N., Adamović, M., Grubić, G., Kolajić, V., Bočarov-Stančić, A. (2003-b): The influence of Min-A-Zel Plus on biochemical, microbiological and mycotoxicological parameters of lucerne silages. Journal of Agricultural Sciences 48, 2.

Grubić, G., Đorđević, N., Koljajić, V. (2001): Lucerka u ishrani krava. Arhiv za poljoprivredne nauke, 62, 220, 275-284.

Koljajić, V., Đorđević, N., Grubić, G., Jovanović, R., Pavličević, A., Jokić, Ž., Dinić, B. (1997): The Quality of Silages Prepared from Legumes Depending on Methods and Additives Used. Simpozijum „Naučna dostignuća u stočarstvu '97''. Subotica, 21.-25. april. Zbornik radova, str. 203-219.

Koljajić, V., Đorđević, N., Grubić, G., Adamović, M. (2003): The influence of zeolite on the quality of fresh beet pulp silage. Journal of Agricultural Sciences. 48, 1: 77-84.

McDonald, P. (1985): The biochemistry of silage. John Wiley.

Mejakić, V., Stojčić, J., Nedović, B., Vojin, S. (1997): Proizvodne karakteristike novostvorene sorte lucerke (Medicago sativa L.) ''Biljana'' za korištenje. Agroznanje-Banja Luka. 1, 1: 241-255.

StatSoft, Inc. (2003). STATISTICA (data analysis software system), version 6. www.statsoft.com.

UTICAJ DODAVANJA ZEOLITA NA KVALITET SILAŽA SVEŽE LUCERKE

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Rezime

U ogledu je ispitivan uticaj dodavanja prirodnog zeolita na hemijski sastav i kvalitet silaža lucerke. Lucerka je silirana bez i sa dodatkom tehnološki obrađenog prirodnog zeolita (pod nazivom Min-A-Zel, proizvod ITNMS – Beograd) u količini od 80, 400 i 2000 g na 100 kg sveže lucerke (sa oko 250 g/kg suve materije). Siliranje lucerke je obavljeno odmah po košenju i posle 24 sata (dvofaktorijalni eksperiment, 4 × 2). Drugi deo eksperimenta (posle 24 sata) izveden je u cilju dodatne kontaminacije lucerke mikroorganizmima iz vazduha.

Rezultati obavljenih istraživanja pokazuju da dodavanje tehnološki obrađenog prirodnog zeolita pri siliranju lucerke doprinosi intenziviranju fermentacije i povećanju produkcije mlečne kiseline, uz postizanje nižih pH vrednosti i povoljnijeg odnosa mlečne prema ukupnim kiselinama. Uticaj navedenih doza zeolita na standardni hemijski sastav je bio manji, i pretežno je relativnog karaktera. Jedine realne promene su povećanje stepena suve materije i povećanje količine mineralnog ostatka.

Prema DLG metodi kontrolna silaža je svrstana u III klasu kvaliteta, silaže sa nižom i srednjom dozom zeolita u II klasu, a silaža sa maksimalnom dozom zeolita u I klasu kvaliteta.