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INFLUENCE OF ADDITION OF ZENURAL 70, UREA AND MIN-A-ZEL PLUS ON CHEMICAL COMPOSITION AND QUALITY OF WHOLE MAIZE PLANT SILAGE

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Abstract: The influence of addition of Zenural 70, urea and Min-A-Zel Plus on chemical composition and quality of whole maize plant silage with different degree of compression was investigated in the paper. Experiment was two-factorial (2x3) with three replications, where factor A was a degree of compression (A_1 = 680 g/dm^3; A_2 = 550 g/dm^3), while factor B was an additive type (B_1=control; B_2=5 g/kg urea+2 g/kg Min-A-Zel Plus; B_3=5 g/kg Zenural 70).

Chemical analyses showed that with the addition of Zenural 70 and urea there was significant increase of pH value, total protein, mineral ammonia and soluble nitrogen content. The type of additive had no significant effect on production of lactic, acetic and butyric acid, while in silages with higher degree of compression (680 g/dm^3) there was significantly more butyric acid. All silages were graded first class according to DLG and Flieg method, with the exception of lower compressed silage with added urea and Min-A-Zel Plus, which according to Flieg was second class. According to Zelter method, silages with added Zenural 70 were II and III class, while treatments with added urea and Min-A-Zel Plus were IV and V class.

Key words: maize, silage, Zenural 70, urea, Min-A-Zel Plus.

Introduction

High price of protein feedstuffs had strong impact on economical results in animal production. Due to microorganisms present in the reticulo-rumen in

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ruminants, the use of forages is very efficient but they also possess capability to utilize non protein nitrogen (NPN) and produce amino acids that can be utilized by the host animal. NPN is degraded in the rumen to ammonia, and using the available energy they produce protein with high biological value. The ruminant digests those microorganisms (bacteria, protozoa and fungi) in the intestines and utilize their amino acids. This possibility is important because NPN is much cheaper source of nitrogen (N) than protein (Djordjević and Šestić, 1994)

The most important NPN source of nitrogen is urea $CO(NH_2)_2$, which has average N content between 42 and 46%. One kilogram of urea is theoretically equivalent to 2.8 kg protein. Urea is used as an additive in concentrate part of the ration and also during the ensiling process of the whole plant, high moisture grain and ear maize silag (Dinić and Djordjević, 2005). The recommendation for urea addition in the whole plant maize silage is 0.5% (5 g per kg silo mass). Urea and other NPN sources of N can supply about 1/3 of total protein requirements in ruminants, if ample energy is provided in the diet. If the amount is increased above this recommendation and if there is not enough energy available, or if the enzyme urease is present in high concentrations (for example, if raw soybean grain is used), the excessive levels of ammonia are produced, which quickly pass into the blood and may be poisonous. In severe cases this may be fatal to the animal (Grubić et al., 1996). The additives based on urea fixed with various binders were produced in our country, with the aim to better utilize the capacity of ruminants to use NPN: "Škrobamid" (starch + urea), "Reamid" (dry sugar beet pulp + urea), "veštačka sačma" (extruded maize meal + urea), "Benural-S" (preparation based on aluminosilicates of bentonite origin + urea and sulfur).

In recent years urea is again a very attractive additive for ruminant diets, considering that its use decreases feeding expenses significantly. There are several products available on the market: Zenural, Zenural 70, Zenural M (produced by (P.P.P. »Nježić produkt« d.o.o.)). Zenural 70 is recommended as additive for use in the production of whole maize plant silage in the amount of 0.7 to 1%. It contains 70% urea and bentonite, which enablies stable and slower release of nitrogen from urea. In this experiment Zenural 70 is compared to chemically pure urea, which was combined with Min-A-Zel Plus, also with the aim to control urea hydrolysis. There was a series of experiments already done, where additives based on natural zeolite were used in maize plant and high moisture grain ensiling, and also for fresh sugar beet pulp and lucerne silage (Adamović et al., 2001; Koljajić et al., 2002,2003; Grubić et al., 2003; Djordjević et al., 2003-a,b; 2004-a,b). The obtained results show that zeolites have beneficial effects on silage quality by binding part of the moisture and enhance the activity of lactic acid bacteria. It is also confirmed that zeolite addition decreases mycotoxins in silages, especially if it was not properly compressed during ensiling process (Adamović et al., 2001).

Material and Methods

The experiment was two-factorial (2x3) with three replications, where factor A was a degree of compression (A_1 = 680 g/dm^3; A_2 = 550 g/dm^3), while factor B was an additive type (B_1 = control; B_2 = 5 g/kg urea + 2 g/kg Min-A-Zel Plus; B_3=5 g/kg Zenural 70). The urea used was chemically pure (*pro analysis*) with protein equivalent of 291.6%, while Zenural 70, according to its specification, had protein equivalent of 197%.

Whole plant maize used for ensiling was ZP-677 hybrid, in wax phase, with about 350 g/kg dry matter. Maize was collected by hand and was cut with electrical cutter to the particle size of 1-2 cm; it was mixed with additives and compressed in experimental silos with volume of 60 dm^3. The silage surface was protected with PVC foil and covered with about 10 kg of shingle. Silos were also closed with their lids.

After 56 days the silos were opened and representative samples were taken for analysis. The chemical and silage quality analyses (AOAC, 1984) were done in the Animal Nutrition Laboratory at the Faculty of Agriculture, Zemun. Silage quality was evaluated according to Zelter, DLG and Flieg methods. Statistical analysis was done by Analysis of variance and Tuckey honestly significant test by Statistica v. 6 software.

Results and Discussion

Urea [$CO(NH_2)_2$] addition significantly increased the percentage of crude protein (Kjeldahl process does not differentiate true protein from other N sources), which is shown in table 1. The variation in crude lipids can be explained by partial extraction of lactic acid with diethyl ether (Barnett, 1954), and because of that significantly greatest amount of lipids was detected in silage with highest amount of lactic acid. The variability in crude fiber was not significant, although it may be observed that it was decreased in treatments where urea was used. Some previous results showed influence of ammonia, used directly as conservant, on degradation of lignocelullosic complex, which was probably what happened in this experiment too (Djordjević and Dinić, 2003). Variations in NFE content were also not significant, while treatment with additives had significantly higher amount of mineral matter, considering that bentonite and zeolite were used.

The pH values were significantly increased in treatments with additives, which was expected considering the alkaline properties of urea (table 2). In spite of that pH values of obtained silages were within the optimal range – 3.8 to 4.0. The pH values and dry matter content are the most important factors that control

the intensity of proteolysis, although they cannot completely prevent it (Carpintero et al., 1979).

T a b. 1. - Chemical composition of silages, g/kg DM

Parameters	Pressing 680 g/dm^3			Pressing 550 g/dm^3			Significance
	Control	0.5% urea + 0.2% org.zeolit	0.5% zenural	Control	0.5% urea + 0.2% org.zeolit	0.5% zenural	
DM, g/kg	357.11 b	372.93 a	344.24 c	353.98 b	351.42 bc	356.55 b	AxB=0.000
Crude proteins	71.85 b	88.04 a	82.96 c	72.76 b	88.23 a	81.83 c	B=0.000 AxB=0.000
Crude lipids	64.28 a	50.34 b	48.77 b	49.86 a	46.11 b	50.23 b	AxB=0.011
Crude fibers	171.28	169.54	170.00	172.03	170.26	168.93	-
NFE	644.63	641.86	648.90	656.95	644.62	648.58	-
Ash	47.96 c	50.22 ab	49.37 abc	48.34 bc	50.78 a	50.43 a	B=0.000 AxB=0.002

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

T a b. 2. - Biochemical changes in silages, g/kg DM

Parameters	Pressing 680 g/dm^3			Pressing 550 g/dm^3			Significance
	Control	0.5% urea + 0.2% org zeolit	0.5% zenural	Control	0.5% urea + 0.2% org zeolit	0.5% zenural	
pH	3.40 d	3.93 ab	3.89 b	3.82 c	3.98 a	3.88 bc	B=0.001 AxB=0.000
NH_3-N g/kg N	67.52 b	408.11 a	276.52 c	65.55 b	456.41 a	302.24 c	B=0.000 AxB=0.000
Soluble N, g/kg total N	403.89 e	649.94 b	524.15 d	359.53 f	691.47 a	562.72 c	B=0.000 AxB=0.000
Lactic acid	47.83 a	38.93 b	40.21 ab	39.61ab	37.60 b	43.49 ab	AxB=0.016
Sirćetna kiselina							
Free	13.44 ab	12.34 ab	10.73 ab	10.55 ab	17.62 b	10.05 ac	AxB=0.033
Bonded	7.55	7.71	8.06	9.16	10.03	9.45	-
Total	20.99	20.05	18.79	19.71	27.65	19.50	-
Buterna kiselina							
Free	0.00 b	0.00 b	0.17 a	0.00 b	0.00 b	0.00 b	AxB=0.001
Bonded	0.00	0.06	0.00	0.00	0.00	0.00	-
Total	0.00 b	0.06 ab	0.17 a	0.00 b	0.00 b	0.00 b	A=0.026 AxB=0.003

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

The percent of ammonia N compared to total N is the main indicator of the degree of proteolysis. Presence of ammonia in silages that do not have butyric acids is explained by the activity of plant enzymes (McDonald, 1991). In the

investigated silages total ammonia N was from two sources: from the degraded plant protein and from hydrolyzed urea [$CO(NH_2)_2 + H_2O = CO_2 + 2(NH_3)$]. Treatments with urea and zeolite had higher level of ammonia N, considering that this combination had highest protein equivalent. For the same reason, these treatments had significantly highest amount of soluble N. Amounts of ammonia N in control silages were below 100 g/kg, which is regarded as the upper limit for quality silages (Ensilage, 1978).

Apart from the increase in crude protein content, additives based on urea had important role in providing aerobic stability of silages. It is experimentally confirmed that alkaline silage additives bind part of the produced organic acids, and in that way they enhance the fermentation and utilization of sugars, which decreases the danger from later fermentation. This possibility is especially important for maize plant silages which may have problem with secondary fermentation due to residual sugars. Ammonia also has fungicide effects (Djordjević and Šestić, 1994).

The investigated factors alone had no significant influence on the production of lactic and acetic acid. Butyric acid was detected only in treatments with higher level of compression. The interaction of both investigated factors had significant influence on the amount of lactic acid, free acetic acid, and total butyric acid.

T a b. 3. - Relative ratio of acids (%) and silage quality

	Pressing 680 g/dm^3			Pressing 550 g/dm^3		
	Control	0.5% urea + 0.2% org.zeolit	0.5% zenural	Control	0.5% urea + 0.2% org.zeolit	0.5% zenural
Lactic	69.50	65.94	67.96	66.77	57.62	69.04
Acetic	30.50	33.96	31.76	33.23	42.38	30.96
Butyric	0.00	0.10	0.28	0.00	0.00	0.00
Quality by DLG	I	I	I	I	I	I
Quality by Flieg	I	I	I	I	II	I
Quality by Zelter	I	IV	II	I	V	III

Evaluation of silage quality was done according to DLG, Flieg and Zelter Methods. The first one evaluates pH value and relative ratio of lactic, acetic and butyric acid. The second one relative ratio of lactic, acetic and butyric acid, while the third evaluates the amount of ammonia N, acetic and butyric acid. According to DLG and Flieg, all silages were ranked as first class, with the exception of low compressed silage with urea and Min-A-Zel Plus (table 3). According to Zelter method, which takes into account ammonia, silages with added urea and Min-A-

Zel Plus were ranked IV and V class, while those with Zenural 70 were ranked II and III class. Silages produced with lower compression and urea additives had one class lower quality. It is clear that used methods ranks silages differently. DLG and Flieg methods do not consider additives used, while Zelter method ranks those silages as barely usable or unusable. The recommended levels of additives need to be critically re-evaluated in order to obtain valid picture about silage usefulness as feedstuffs.

Conclusion

Treatments with additional urea, combined with Min-A-Zel Plus and Zenural 70 had significantly more crude protein, ammonia and soluble nitrogen and minerals. However, the level of fermentation and the amount of organic acids with short C chain was not significantly altered, so that all silages were ranked first class according to DLG and Flieg classification. On the contrary, Zelter method, which is also evaluating amounts of ammonia nitrogen, ranked silages with Zenural 70 II and III class, and silages with Min-A-Zel Plus as IV and V class, which is on the border of usability and non useable. Due to huge differences between silage evaluation methods, the selection of the method should be done according to real silage quality parameters.

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UTICAJ DODAVANJA ZENURALA 70, UREE I MINAZEL-A-PLUS NA HEMIJSKI SASTAV I KVALITET SILAŽA CELE BILJKE KUKURUZA

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R e z i m e

U eksperimentu je ispitivan uticaj dodavaja Zenurala 70 i uree na hemijski sastav i kvalitet silaža cele biljke kukuruza sa različitim stepenom sabijenosti. Eksperiment je postavljen kao dvofaktorijalni ogled (2x3) u tri ponavljanja, gde je faktor A bio stepen sabijenosti (A_1 = 680 g/dm^3; A_2 = 550 g/dm^3), a faktor B vrsta dodatka (B_1 = kontrola; B_2 = 5 g/kg uree + 2 g/kg Min-A-Zel-a Plus; B_3 = 5 g/kg Zenurala 70).

Hemijskim analizama je utvrdjeno da je pri dodavanju Zenurala 70 i uree došlo do signifikantnog povećanja pH vrednosti i količine sirovih proteina, mineralnih materija, amonijačnog i rastvorljivog azota. Vrsta dodatka nije značajno uticala na produkciju mlečne, sirćetne i buterne kiseline, dok je u silažama sa većim stepenom sabijenosti (680 g/dm^3) ustanovljeno statistički više buterne kiseline. Sve silaže su prema DLG i Flieg-ovoj metodi ocenjene prvo klasom kvaliteta, sa izuzetkom silaže manje sabijenosti sa dodatkom uree i Min-A-Zel-a Plus, koja je prema Flieg-u ocenjena drugom klasom. Prema Zelter-ovoj metodi silaže sa dodatkom Zenurala 70 su bile II i III klase, dok su tretmani sa dodatkom uree i Min-A-Zel-a plus bile IV i V klase.

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