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THE INFLUENCE OF ZEOLITE ON THE QUALITY OF FRESH BEET PULP SILAGES

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Abstract: The influence of different doses of natural zeolite addition on chemical composition and quality of beet pulp silages was investigated. Beet pulp was ensiled in the sugar factory in Požarevac immediately after they were obtained, or after 9 or 17 days. The two-factorial trial was conducted, where the first factor (A) was the time of ensiling expressed in days after the pulp was obtained (a_1= 0; a_2 = 9; a_3 = 17), while the second factor (B) was the amount of zeolite added (b_1= 0; b_2 = 0.05; b_3 = 0.25 and b_4 = 1.25% in dry matter or 0; 50; 250 and 1250 g zeolite per 100 kg of raw beet pulp). Sample collection for standard chemical composition and quality estimation was taken 60 days after the beginning of the ensiling.

The results from the literature show that adding technologically processed natural zeolite (Min-a-Zel, produced by ITNMS, Belgrade) while ensiling beet pulp has significant influence on the increase of lactic acid production, decrease in bonded acetic acid content and lower pH value. The influence of explained doses of zeolite on standard chemical composition is smaller and mostly of relative value. The only real changes in chemical composition are the increase in dry matter and mineral content. In the ensiling of the beet pulp stored in the longer period of time, the more intensive fermentation processes were achieved and the production of organic acids was larger, which has better conserving effects on silage.

Key words: raw beet pulp, silage, natural zeolite.

I n t r o d u c t i o n

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Sugar beet is an important culture, which is providing raw materials for 42% of the word's sugar production, while the other 58% of sugar is produced from sugarcane. During beet processing a number of by-products are obtained: heads and tops, pulp and molasses, which can be used in various ways in domestic animal feeding. However, their use as raw materials is time limited and their dehydration requires large energy costs. This is the reason why ensiling is the most suitable method of conservation that enables their use during longer periods of time.

The main problems characteristic of sugar beet pulp ensiling is: high moisture, increased temperature of fresh pulp and sometimes long depositing time.

Literature survey

The greatest problem in sugar beet pulp ensiling is high moisture (about 90%), but with additional pressing the amount of dry matter is doubled. However, if dry matter content is above 25%, the pressing is not successful due to pulp elasticity (Kasapović et al. 1994). Slow cooling of freshly pressed pulp can also have negative influence on the structure and quality of silages. This is why pulp ensiling is recommended in horizontal objects in layers up to 2 m thick or in vertical siloses with diameter to 3 m. Since pulp has high carbohydrate content, there were attempts to increase their protein content. Sretenović et al. (1992) used ammonia, while Čobić et al. (1995) used urea. They concluded that urea alone has negative effects on fermentative processes. In some investigations fresh beet pulp was used as a carbohydrate supplement when ensiling fruit pulp, and its influence was positive in the increase of lactic acid production and decreasing of the pH value (Pavličević et al. 1988; 1991).

Material and Method

The aim of this experiment was to investigate the influence of natural zeolite, used in various doses and at different time intervals, on chemical composition and quality of beet pulp silages. It was assumed that zeolite might influence not only moulds activity and the amount of mycotoxins produced, but also the intensity of fermentation in the ensiled material. Because of that, ensiling was done on 0, 9 and 17 days after pulp production with the aim to enable its natural contamination with microorganisms.

In this experiment a technologically processed natural zeolite (Min-a-Zel) produced by ITNMS, Belgrade was used.

Beet pulp was ensiled in the sugar factory in Požarevac immediately after its production and after 9 or 17 days. The trial was set as two-factorial (table 1),

where the first factor (A) was the time of ensiling expressed in days after the pulp was obtained (a_1= 0; a_2 = 9; a_3 = 17), while the second factor (B) was the amount of Min-a-Zel added (b_1= 0; b_2 = 0.05; b_3 = 0.25 and b_4 = 1.25% in dry matter or 0; 50; 250 and 1250 g zeolite per 100 kg of raw beet pulp).

T a b. 1. - Plan of fresh beet pulp ensiling

A-Ensiling time	Zeolite doses, g/kg fresh pulp			
	b_1	b_2	b_3	b_4
a_1 – O days	0	50	250	1250
a_2 – 9 days	0	50	250	1250
a_3 – 17 days	0	50	250	1250

Ensiling was done in plastic containers. The pre-measured amount of Min-a-Zel was first mixed with maize meal (2 kg meal per 100 kg of pulp) in order to obtain better mixing. Then, the mixing with Min-a-Zel was done and their pressing into the containers. At the end, the material was covered with plastic foil and the containers were tightly closed.

Experimental containers were opened 60 days after they were closed and samples for chemical and quality analyses were taken (AOAC, 1984). The obtained results were analyzed by statistical procedure of variance analysis and testing was done to determine significance of the influence of factors investigated (Snedecor and Cochran, 1982).

Results and Discussion

Chemical composition of the starting material is shown in table 2 and it is similar to the composition given by Demarquilly et al. (1978), Kamphues and Dayen (1983) and Sretenović et al. (1992).

The different time of pulp standby until ensiling has no significant influence on dry matter content in silages (table 3). With the increase of the amount of zeolite, and of maize meal as its carrier, a significant increase of dry matter (b_1-b_4) was observed.

The amount of protein was significantly decreased in silages prepared with pulp standing by for 9 and 17 days (a_1-a_3). A possible explanation for this is that with the drying of silage samples part of nitrogen compounds (ammonia) are lost. The increase in the amount of protein in silages with added Min-a-Zel can be of purely relative character, because of the increase of minerals from the additive (b_1-b_4).

Crude fiber content was significantly increased in silages prepared with pulp that was on standby for 9 and 17 days (a_1-a_3). Since those are very stable

compounds and there were no losses it is possible that their increase was relative because of the decrease of protein and NFE. Similarly, it is possible to explain the increase in crude fiber content with the increase of zeolite dose (b_1-b_4).

T a b. 2. - Chemical composition of the starting material, g/kg DM

Parameters	Ensiling time		
	0 day	9 days	17 days
Dry matter	244.9	187.5	210.7
Crude protein	82.5	99.7	109.1
Crude fiber	201.4	247.7	260.2
Crude lipids	16.8	11.7	12.9
NFE	660.1	599.3	569.7
Ash	39.2	41.6	48.1

The increase of crude fat content in silages with pulp that was on standby for 9 and 17 days and in those with Min-a-Zel added is among other, things, the result of imperfections in the Soxlett method of lipid extraction, because lactic acid is extracted in the process (Barnett, 1954). It those silages, the increased amount of lactic acid can be noticed due to improved fermentation conditions (table 4).

The amount of NFE decreases in silages with pulp that was on longer standby and that had Min-a-Zel added, which is the result of its use in fermentation and production of acetic and lactic acids.

The ash content is changed mostly with the use of zeolite, so that on the b_4 treatment it is double compared to the silage without zeolite. It is normal because zeolite is a mineral additive. Smaller increase of ash content in silages made of pulp on standby for 9 and 17 days can be explained as a change relative in character.

The decrease in pH value in silages made from pulp with a longer standby (table 4) is the result of more intensive lactic acid fermentation and can be explained by higher presence of lactic acid bacteria from the air. The number of lactic acid bacteria in different plant materials is small at the beginning, because plants possess protective materials (phytoncides). Jambor and Šiške (1997) wrote that the number of epiphyte lacto bacteria on plants is only $10\text{-}10^2$ bacteria per gram of green mass. This is why it is necessary to have some time when lacto bacteria became present in needed numbers or the inoculation is done (Koljajić et al. 1998). With the beet pulp, as an additional problem, there is a negative influence of previous pulp chemical and heat processing. However, pulp depositing for 9 or 17 days enabled various microorganisms to enter it from the air. Because of this silages with more micro flora had more lactic acid (table 4). In

all treatments with Min-a-Zel, significantly higher lactic acid amounts were found, by 35-65%, and as a result of improved lactic acid fermentation conditions in ensiling the maize plant with similar organically modified Min-a-Zel added. One of the explanations for this lies in the fact that zeolite is not only mycotoxins and gas adsorbent, but it also absorbs water. Lactic acid bacteria are more tolerant to the increased osmotic pressure compared with other bacteria, which is why they produce more lactic acid in silages with more dry matter (McDonald, 1981). Also, in the treatments with zeolite there are other conditions favorable for their activity, especially because Min-A-Zel adsorbs mycotoxins (Adamović et al. 2001). Adamović et al. (2001) observed increase of lactic acid production from 73 to 82% in best conditions, while the increase was from 49 to 75% in less favorable conditions.

T a b. 3. - Chemical composition of silages, g/kg DM

Parameters	Treatments						
	a_1	a_2	a_3	b_1	b_2	b_3	b_4
Dry matter	22.42 a	22.55 a	22.37 a	21.84 a	22.26 b	22.31 b	23.40 c
Crude protein	95.07 b	86.47 a	84.80 a	101.03 c	81.53 a	80.30 a	92.27 b
Crude fiber	220.10 b	234.70 a	233.12 a	222.13 a	226.80 a	233.20 b	235.10 b
Crude lipids	7.57 a	9.8 a	12.07 b	9.50 a	10.23 ab	12.97 c	10.57 b
NFE	629.62 c	610.52 b	601.00 a	621.80 b	634.87 c	624.03 b	574.17 a
Ash	47.62 a	58.50 b	66.00 c	45.53 a	46.57 a	49.50 b	87.90 c

T a b. 4. - The parameters of biochemical changes in silages, g/kg DM

Parameters	Treatments						
	a_1	a_2	a_3	b_1	b_2	b_3	b_4
pH	3.99 c	3.70 b	3.57 a	3.90 a	3.74 b	3.95 a	3.43 c
Lactic acid	48.24 a	113.88 b	125.96 c	69.67 a	106.41 b	93.96 b	114.06 c
Acetic acid:							
Free	15.44 a	15.46 a	19.21 b	18.69 b	17.59 b	16.76 b	13.79 a
Bonded	12.13 a	26.46 b	36.96 c	27.15 a	25.09 a	28.58 a	26.56 a
Total	27.57 a	41.92 b	56.17 c	45.84 b	42.68 ab	45.34 b	40.35 a
Butyric acid	-	-	-	-	-	-	-

The amount of free and bound acetic acid was also increased with later ensiling of pulp as a result of a more numerous micro flora. In contrast, with the increase of Min-a-Zel dose the content of free acetic acid was decreased by 30%

in the treatment with maximal dose of additive. Similar influence of Min-a-Zel was also observed by Adamović et al. (2001).

The presence of butyric acid was not observed in experimental silages.

A favorable relative ratio of lactic acid to total acids was observed with later pulp ensiling (table 5). With the increase of Min-a-Zel dose the content of lactic acid in total acid content by 7-14 was observed.

T a b. 5. - Silage quality grading by DLG method

Parameters	Treatments						
	a_1	a_2	a_3	b_1	b_2	b_3	b_4
Lactic/total acid	0.63	0.73	0.69	0.60	0.71	0.67	0.74
Acetic/total acid	0.37	0.27	0.31	0.40	0.29	0.33	0.26
Butyric/total acid	0	0	0	0	0	0	0
Points	48	49	48	47	49	49	48
Class	I	I	I	I	I	I	I

In all silages the presence of lactic acid was observed in the total amount of 60 or more percent. Dominant type of lactic acid fermentation, lack of butyric acid and favorable pH values lower than 4.00 contributed to the quality of silages, which were all ranked as first class.

Conclusion

The results of investigation show that addition of technologically processed natural zeolite (Min-a-Zel), when ensiling sugar beet pulp, has influence on the increase of lactic acid production, decrease of content of bonded acetic acid and pH value. The influence of adding Min-a-Zel on chemical composition is less pronounced and has mostly relative character. The only real changes occurred as the increase of ash content. With later ensiling of beet pulp more intensive fermentative processes are achieved and more total organic acids are obtained, which has conserving effects on silage.

The use of Min-a-Zel even in the material that had sufficient fermentable sugars induces more intensive activity of lactic acid bacteria.

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UTICAJ ZEOLITA NA KVALITET SILAŽA SIROVIH REPINIH REZANACA

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R e z i m e

U ogledu je ispitivan uticaj dodavanja različitih doza prirodnog zeolita na hemijski sastav i kvalitet silaža spremljenih od repinih rezanaca. Rezanci su silirani u fabrici šećera u Požarevcu, odmah po dobijanju ili posle 9 i 17 dana. Ogled je postavljen kao dvofaktorijalni, gde je prvi faktor (A) bio vreme siliranja, izraženo u danima po dobijanju rezanaca ($a_1 = 0$; $a_2 = 9$ i $a_3 = 17$ dana), a drugi faktor (B) količina zeolita ($b_1 = 0$; $b_2 = 0,05$; $b_3 = 0,25$ i $b_4 = 1,25$% u odnosu na suvu materuju, odnosno, 0; 50; 250 i 1250 g zeolita na 100 kg sirovih rezanaca. Uzimanje uzoraka za utvrdjivanje standardne hemijske analize i parametara kvaliteta silaža obavljeno je 60 dana po siliranju.

Rezultati obavljenih istraživanja pokazuju da dodavanje tehnološki obradjenog prirodnog zeolita (Min-a-Zel, proizvod ITNMS, Beograd) pri siliranju repinih rezanaca signifikantno utiče na povećanje produkcije mlečne kiseline, smanjenje sadržaja vezane sirćetne kiseline i smanjenje pH vrednosti. Uticaj navedenih doza zeolita na standardni hemijski sastav je bio neznatan. Jedine promene količine pojedinih materija su povećanje stepena suve materije i količine mineralnog ostatka. Pri siliranju repinih rezanaca koji su duže stajali na depou postižu se intenzivniji fermentacioni procesi i dobija se veća ukupna količina organskih kiselina koje imaju konzervišuće dejstvo za silažu.

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