

EFFECTS OF THE USE OF ACETIC ACID AS THE CONSERVANT IN LUCERNE ENSILING

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Abstract: The influence of acetic acid as the chemical conservant in three doses (4, 6, 8 g/kg green mass) on the intensity of fermentation and proteolysis in lucerne silage was investigated. On the basis of chemical analysis, it was found that with the increase of conservant dose the pH value decreased, aminogenesis and nitrogen solubility was limited. In silages treated the absolute and relative domination of acetic acid was found in total acid content. The increase of free and bonded acetic acid was discovered with the increase of conservant dose. Free butyric acid was not detected, while bonded butyric acid was present in negligible concentration, without effect on silage quality.

Compared to control silage (III quality class according to DLG and Zelter method), a significant increase of acetic acid in silages resulted in the decline of their quality, and they were ranked as not useful (V quality class according to DLG method), or on the margin of usefulness (IV quality class according to Zelter method).

In spite of some foreign references, domestic experiences show that acetic acid is not an effective conservant and it is not recommended for that use for lucerne that is not simple to ensile.

Key words: lucerne, silage, acetic acid, fermentation, proteolysis.

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

High buffering value, low amount of sugars and significant content of moisture inhibit production of quality lucerne silage. This is why some special

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procedures or additives, such as wilting, mixing with carbohydrate feeds and biological preparations, combining with plant material that is easy to ensile or chemical conservation are needed (Koljajić et al., 1997).

The investigation of possibilities of chemical conservation of lucerne is more than 100 years old. In many experiments various conservants – mineral and organic acids; their salts and gaseous substances were used with more or less success. Some of them were patented under various commercial names and are used around the world.

The use of acetic acid as a conservant in lucerne ensiling is still controversial. Most authors do not recommend the use of this conservant due to the decrease in animal intake of silages high in acetic acid. However, McDonald (1981), citing Deswysena, denies this and writes that acetic acid has effect similar to formic acid. Taranov (1982) explained that acetic acid is one of the important products of ruminal fermentation and that it is natural in animal organism, therefore he recommends it in the amount of 5l/kg green mass for hard ensiling feeds.

The aim of this experiment was to investigate the effects of the use of various doses of acetic acid on the intensity of fermentation and proteolysis in lucerne silages, and to possibly obtain information about doses that may be recommended for practical use.

Material and Methods

Ensiling of lucerne cultivar NS - Mediana ZMS V of the second cut in the beginning of bloom was done in experimental silos with the volume of 60 dm² with the maximum compression of previously chopped and treated mass, covering and hermetical sealing. The experiment was established as randomized plan and each treatment had three replicas. The effects of the dose of acetic acid (0; 4; 6 and 8 g/kg green mass) on the intensity of fermentation and proteolysis in lucerne silage. The concentration of used acetic acid was 99%.

When the fermentation ended, samples were taken and laboratory analysis of chemical composition, quality and proteolysis (AOAC, 1984) were done. Silage quality was estimated according to DLG and Zelter methods. Statistical analysis was done as analysis of variance (Snedecor and Cochran, 1982).

Results and Discussion

For most parameters of chemical composition it was found that the changes in conservant dose had no significant influence (Tab. 1). Decrease in lipid content of silages with the acetic acid added was, among other reasons, the result of the imperfections of Soxhlet method, because with the extraction of fats with diethyl

ether substantial amounts of lactic acid, which is not volatile, are extracted (Barnett, 1954).

T a b. 1. - Chemical composition of silages

Parameters	Acetic acid dose, g/kg green mass				Significance
	Control	4	6	8	
DM, g/kg	196.59	204.31	202.76	200.04	NS
<u>g/kg DM:</u>					
Crude protein	195.21	197.27	198.75	199.17	NS
Crude lipids	65.26 a	52.33 b	53.51 b	62.19 a	*
Crude fibre	284.94	284.16	284.23	283.44	NS
NFE	326.24	340.89	331.66	323.07	NS
Ash	128.36	125.35	131.85	132.13	NS

^{a,b} Values in the same row are statistically significantly different (P<0.05)

The pH values of lucerne silage without conservant were high (Tab. 2) and characteristic of this plant species. With the increase of acetic acid dose, the pH value decreased. At that, levels of acidity found were the result of dissociation of produced acids as well as the used conservant. The amount of lactic acid was decreased absolutely and relatively (compared to total acid content) along with the increase of acetic acid dose (Tab. 2 and 3). Obviously, the presence of higher amount of acetic acid as a conservant added had dissimulating effect on lacto bacteria activity. In contrast, with the increase of conservant dose, the amount of acetic acid as free, bonded and total was increased in silages. The amount of free acetic acid was doubled in silage with the maximum conservant dose, while the increase in bonded acetic acid was much less pronounced. Butyric acid was discovered only in bonded form and it was present in all silages investigated, but in very low percent.

T a b. 2. - Biochemical changes in lucerne silages

Parameters	Acetic acid dose, g/kg green mass				Significance
	Control	4	6	8	
pH	4.97 b	5.09 a	4.88 c	4.82 c	*
<u>g/kg DM:</u>					
Lactic acid	43.92 a	25.59 b	22.19 b	16.88 c	**
Acetic acid:					
Free	28.19 c	31.80 c	47.88 b	60.35 a	**
Bonded	52.57 c	57.79 b	68.02 a	60.18 b	*
Total	80.76 c	89.59 b	115.90 a	120.53 a	**
Butyric acid:					
Free	0.00	0.00	0.00	0.00	-
Bonded	0.69	1.69	2.07	1.19	NS
Total	0.69	1.69	2.07	1.19	NS
<u>g/kg N:</u>					
Ammonia N / total N	136.92 c	155.50 a	144.13 b	123.54 d	*
Soluble N / total N	722.75 a	704.75 a	613.65 b	603.47 b	*

^{a,b,c,d} Values in the same row are statistically significantly different (P<0.05)

With the increase of acetic acid dose there was the decrease in the percent of ammonia and soluble nitrogen within total nitrogen. However, even in the treatment with the maximum conservant dose the amount of ammonia and soluble nitrogen is above the values normal for good quality silages, which are 80-120 g/kg for ammonia and 500-600 g/kg for soluble nitrogen according to Dulphy and Demarquilly (1981). The reason for that was probably in the lower degree of dissociation of the dominating acetic acid and with the lower influence on total concentration of H^+ ions in silages.

The amount of acetic acid in relative quantity in all silages presented about 60% and it was increased with the increase of conservant dose. In contrast, the lactic acid content was three times lower in silage with maximum amount of conservant compared to control silage. Butyric acid was in all silages present as less than 1%.

All this shows that effects of acetic acid as lucerne conservant are far below previously investigated chemical conservants in the form of mineral acids (Djordjević et al., 1999, 2001) or formic acid as organic (Dinić et al., 2001).

In order to obtain relevant evaluation of ensiling effects, two methods were used: DLG and Zelter. The first one gives summarized evaluation on the basis of pH value and relative ratio of lactic, acetic and butyric acid in silages, while the other one evaluates the absolute amount of those acids and the percent of ammonia nitrogen.

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

Parameters	Acetic acid dose, g/kg green mass			
	Control	4	6	8
Lactic acid / total acids	35.12	22.04	15.93	12.14
Acetic acid / total acids	64.60	77.23	83.32	87.42
Butyric acid / total acids	0.28	0.73	0.75	0.44
Quality class according to DLG	III	V	V	V
Quality class according to Zelter	III	IV	IV	IV

According to DLG method, the use of acetic acid as a conservant significantly decreased silage quality so that treatments were ranked as V class compared to III class of the control silage (Tab. 3). Zelter method was a little more "forgiving" and the treatments were ranked as IV, which definitely showed decrease in silage quality compared to class III for control silage.

Conclusion

The use of acetic acid as a conservant led to decrease in absolute and relative lactic acid content, reduced aminogenesis and decrease of nitrogen solubility. Significant increase of acetic acid content resulted in decreased silage quality and they were ranked non-usable (V class) according to DLG and on the "border of usability" (IV class) according to Zelter.

Compared to some foreign references, domestic experiences show that acetic acid is not an effective conservant and it is not recommended for that use in lucerne that is not simple to ensile.

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EFEKTI UPOTREBE SIRČETNE KISELINE KAO KONZERVANSA PRI
SILIRANJU LUCERKE

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R e z i m e

U eksperimentu je ispitivan uticaj sirčetine kiseline, korišćene u svojstvu hemijskog konzervansa u tri doze (4, 6 i 8 g/kg zelene mase) na intenzitet fermentacije i proteolize u silažama lucerke. Na osnovu rezultata hemijskih analiza utvrđeno je da je sa porastom doze konzervansa došlo do snižavanja pH vrednosti, ograničavanja aminogeneze i rastvorljivosti azotnih materija. U tretiranim silažama utvrđena je apsolutna i relativna dominacija sirčetine kiseline u ukupnom sadržaju kiselina. Pri dodavanju konzervansa došlo je do porasta količine slobodne i vezane sirčetine kiseline. Slobodna buterna kiselina nije utvrđena u silažama dok je prisustvo buterne kiseline u vezanom obliku bilo zanemarljivo i bez uticaja na kvalitet silaža.

U odnosu na kontrolnu silažu (III klasa kvaliteta po DLG i Zelter-ovoj metodi), značajno povećanje zastupljenosti sirčetine kiseline u tretiranim silažama doprinelo je pogoršanju njihovog kvaliteta, pa su ocenjene kao neupotrebljive (V klasa kvaliteta prema DLG metodi), odnosno, na granici upotrebljivosti (IV klasa kvaliteta po Zelter-ovoj metodi).

I pored nekih stranih preporuka, iskustva iz domaćih istraživanja ukazuju da sirčetna kiselina nije efikasan konzervans, i ne preporučuje se za teže silirajuća hraniva, kakva je i lucerka.

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