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THE EFFECT OF DIFFERENT SILAGE ADDITIVES ON MACROELEMENT CONCENTRATIONS IN ALFALFA SILAGE

DJELOVANJE RAZLIČITIH DODATAKA SILAŽI NA KONCENTRACIJE MAKROELEMENATA U SILAŽI DJETELINE

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SUMMARY

The aim of the study was selected macrominerals determination in alflalfa silages conserved by different silage additives and storage technologies. We conserved alfalfa from second cut, flowering phenophase. In the trial we conserved alfalfa in three variants (UC: untreated control, A: variant with lactic acid bacteria addition, B: variant with lactic acid bacteria and complex of cellulases and hemicellulases addition). All of variants were conserved in silage units (SJ 750) and in silage bags. After the finish of fermentation process we found non-significant ($P>0.05$) differences in Ca, Na and K content in silage units SJ 750, the highest Ca content was detected in control variant UC (13.68 $g.kg^{-1}$ of dry matter). Positive effect of additives application we found in P content (3.75 $g.kg^{-1}$ of dry matter in variant B). After the application of silage additives we found singnificantly lower ($P<0.05$) Mg content in silage units. Non-significant differences in P, Na and K content were detected in silage bags. The highest Ca content (12.22 $g.kg^{-1}$ of dry matter) we determined in variant A (lactic acid bacteria addition). In variants A and B (silage additives application) we found higher P content. In comparison with untreated control, the highest Mg content ($P<0.05$) we found in variant with lactic acid bacteria addition (variant A). In comparison between variants ensiled in silage units and bags, we detected higher Na content in silages from silage units, significantly in control variant UC and variant B ($P<0.05$).

Application of silage additives can influence some minerals content. This effect is positive from mineral nutrition view. In laboratory conditions conserved silages we found higher calcium, sodium and potassium content than in silages made in silage bag.

Key words: alfalfa, silage, additives, minerals, macroelements

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INTRODUCTION

Animals need mineral nutrients for many metabolism functions. The primary source of them are feeds, in which the mineral concentrations affect many factors (Rayburn, 1997). Important source of minerals in ruminant (Underwood, 1981) and non-ruminant (Capcarová et al., 2008) nutrition are forages. Mineral content in feeds depends on plant species, maturity status (Green et al., 1987, Buxton and Fales 1994) and other factors. McDowell and Valle (2002) reported that mineral content in forages depends on soil, drainage and pH, forage species and varieties, forage maturity, pasture management, forage yield and climate. One of mineral nutrient sources in animal nutrition is also alfalfa. Marković et al. (2009) reported that in alfalfa plants there are differences in mineral content in different parts, in leaf and particularly stems. In Europe, there are many references to the effect of silage additives application on alfalfa silage nutrient composition, e. g. Shepaerd et al. (1995), McAllister et al. (1998), Gálik et al. (2009) or Knežević et al. (2009).

MATERIAL AND METHODS

The experiment was realized in practical farm and laboratory conditions. The farm located is in the north of region Trnava (Slovakia). In two partial experiments alfalfa (*Medicago sativa,* L.) from 2nd cut was conserved by different silage technologies. In the first experiment we conserved alflafa in laboratory silage units SJ 750, in the second experiment we conserved alfalfa in farm conditions, in silage bag. Alfalfa plants were cut with a 244.6 $g.kg^{-1}$ dry matter content. After the 48 hours wilting we conserved variant UC (negative control) without additives, in variant A (A_U: silage units, A_B: silage bag) we applied additives with lactic acid bacteria (*Lactobacillus plantarum* MA 18/5U>3.10^{10} $CFU.g^{-1}$, *Propionibacterium acidipropionici* MS01>3.10^{9} $CFU.g^{-1}$) active units. In variant B (B_U: silage units, B_B: silage bag) we applied combined additives with lactic acid bacteria (*Pediococcus acidilacti* MA18/5M>$1.75.10^{10}$ $CFU.g^{-1}$, *Lactobacillus plantarum* MA18/5U>$7.5.10^{9}$ $CFU.g^{-1}$) and complex of cellulase and hemicellulase (EC 3.2.1.4, 10 000 $IU.g^{-1}$) active units. All variants (silage units with a 15 dm^3 volume, silage bag of a 120 t volume) were conserved in four repetitions. Alfalfa silage units were stored in the Laboratory of Conserved Feeds (Department of Animal Nutrition, SUA in Nitra). After 2 storing months we analyzed average laboratory samples of alfalfa silages for macroelements content. For anorganic nutrients analysis standard methods were used according to methods AOAC (2000). In laboratory conditions the average samples were analyzed on dry matter content (drying by 103±2 ^{0}C), and on concentration of calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), and potassium (K). Flame atomic absorption spectrometry, by analyzer AVANTA (GBC) was used. Statistic significance of determined differences was tested by single-factor analysis of variance (ANOVA).

RESULTS AND DISCUSSION

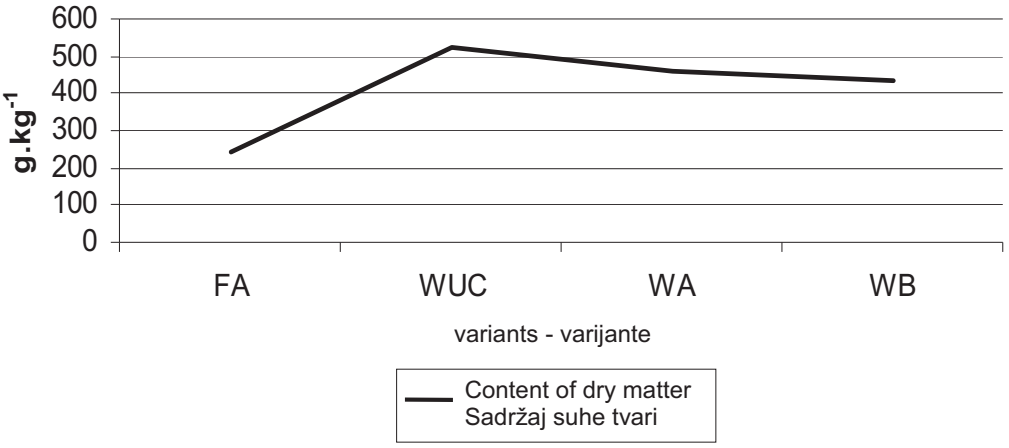
Alfalfa plants were harvested at 244.6 $g.kg^{-1}$ dry matter content. Differences in the dry matter content during the wilting process are showed in figure 1. Atfer the active wilting time (48 hours) in variants A and B silage additives were applied. Wilting time positive by increased dry matter content in alfalfa before ensiling ($P<0.05$). These results are similar to the Hanáčková and Slamka (2004) result. Silage additives application statistically ($P<0.05$) affected dry matter content in variants A and B before ensiling. The lowest dry matter content in wilted alfalfa was found in variant WB (432.4 $g.kg^{-1}$, $P<0.05$). The same effect of additives application was reported by Rizk et al. (2005).

After the wilting time we detected higher Ca, Mg content and lower K content in utreated wilted control variant ($P<0.05$). Similar results were also reported by Marković et al. (2009). In other macroelements we found non-statistical differences ($P>0.05$). In comparison with alfalfa fresh matter we found after the silage additives application statistically lower K content in variant B and higher Mg content in variants A and B ($P<0.05$).

In alfalfa silages conserved in laboratory conditions, silage units SJ 750, we found the highest Ca content (13.68 $g.kg^{-1}$ of dry matter) in untreated

control variant UC_U. The same silage additives application effect we detected also in P content. Our results partially corresponded with Marković et al (2009) results where typical Ca concentration is around 13 % in alfalfa stems. Silage additives application positive by affected Na and K content (P>0.05). Biological additives application statistically (P<0.05) decreased Mg content. The highest Mg content was typical for untreated control variant UC_U (3.17 $g.kg^{-1}$ of dry matter). Marković et al. (2009) found in alfalfa during three stages of maturity total Mg content between 6.59 and 7.59 $g.kg^{-1}$ of dry matter. Our results in Mg content in alfalfa silage are is by them typical only for alfalfa stems.

Figure 1. Changes of dry matter content in alfalfa during wilting
Slika 1. Promjene sadržaja suhe tvari u djetelini za vrijeme venuća



FA: fresh alflafa, WUC: wilted untreated control, WA: wilted variant A, WB: wilted variant B
FA: suha djetelina WUC: uvenula netretirana kontrola WA: uvenula varijanta A, WB: uvenula varijanta B

Table 1. Content of macroelements in fresh and wilted alfalfa matter (in $g.kg^{-1}$ of dry matter)
Tablica 1. Sadržaj makroelemenata u svježoj i uvenuloj djetelini

n = 4	DM	Ca			P			Na			K			Mg		
		$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v
F_A	244.6	12.26^{a}	0.429	3.504	3.82	0.209	5.461	0.998	0.191	19.132	31.06^{ab}	1.020	3.283	2.56^{abc}	0.074	2.909
W_{UC}	524.5	13.64^{ab}	0.296	2.172	3.82	0.227	5.941	0.982	0.107	10.854	28.54^{ac}	1.900	6.654	3.08^{ad}	0.120	3.895
W_A	460.3	11.39	1.378	12.098	3.97^{a}	0.182	4.574	1.52	0.401	26.417	21.65	4.665	21.547	2.91^{b}	0.075	2.580
W_B	432.4	9.95^{b}	0.873	8.775	3.64^{a}	0.187	5.135	2.62	0.897	34.196	20.75^{bc}	0.013	0.062	2.75^{cd}	0.130	4.732

*DM: dry matter, F_A: fresh alfalfa matter, W_{UC}: wilted untreated alfalfa, W_A: wilted alfalfa variant A, W_B: wilted alfalfa variant B.
Values with identical superscripts within one column are significant at P<0.05
DM: suha tvar, F_A: svježa djetelina, W_{UC}: uvenula netretirana djetelina, W_A: uvenula djetelina varijanta A, W_B: uvenula djetelina varijanta B,
Vrijednosti s istim natpisom u jednom stupcu su značajne P<0,05

In alfalfa silages conserved in farm conditions, silage bags, we determined the highest (significantly with negative control variant comparison) Ca content in variant A with lactic acid bacteria addition, 12.22 g.kg^{-1} of dry matter. Higher Ca content we found in variant B also (11.83 g.kg^{-1} of dry matter, P>0.05). In P content we found higher (P>0.05) concentrations in variants with additives (3.60-3.65 g.kg^{-1} of dry matter). McDowell and Valle (2002) reported, that P concentration in forages over 3 % was high. In alfalfa silage we found higher P concentration in comparison with Thomas et al. (2010) results. Non-significant silage application effects we found in alfalfa silages in Na and K contents, also major minerals in forages (McDowell, Valle, 2002). Mg content in silages conserved in silage bags, we found values between 2.75 (variant B_B) and 3.10 g.kg^{-1} of dry matter (variant A_B). These values are by McDowell and Valle (2002) results very low. Statistical differences (P<0.05) in Mg content we found between variants UC_B and B_B.

Table 2 . Content of macroelements in alflalfa silage conserved in silage units (in g.kg^{-1} of dry matter)
Tablica 2. Sadržaj makroelemenata u silaži djeteline konzervirane u silažnim jedinicama (u g.kg-1 suhe tvari)

n = 4	DM	Ca			P			Na			K			Mg		
		$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v
UC_U	510.2	13.68	1.887	13.794	3.81^{a}	0.230	6.039	1.27	0.095	7.486	25.56	1.270	4.970	3.17^{ab}	0.068	2.147
A_U	444.6	12.01	0.880	7.322	3.47^{ab}	0.064	1.845	1.35	0.228	16.834	27.23	1.331	4.889	2.98^{a}	0.092	3.088
B_U	428.6	11.67	1.212	10.383	3.75^{b}	0.148	3.933	1.30	0.168	12.944	26.05	1.426	5.474	2.92^{b}	0.094	3.200

*DM: dry matter, UC_U: untreated control variant alfalfa silage, A_U: alfalfa silage variant A, B_U: alfalfa silage variant B.
Values with identical superscripts within one column are significant at P<0.05
DM: suha tvar, UCU: netretirana kontrolna varijanta silažne djeteline, Au: silaža djeteline varijanta A, Bu: silaža djeteline varijanta B
Vrijednosti s istim natpisom u jednom stupcu su značajne P<0,05

Table 3. Content of macroelements in alfalfa silage conserved in silage bag (in g.kg^{-1} of dry matter)
Tablica 3. Sadržaj makroelemenata u silaži djeteline konzervirane u silažnim vrećama

n = 4	DM	Ca			P			Na			K			Mg		
		$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v
UC_B	464.9	11.18^{a}	0.145	1.301	3.49	0.082	2.352	0.892	0.043	4.824	24.46	0.488	1.996	3.08^{a}	0.064	2.090
A_B	416.4	12.22^{a}	0.245	2.004	3.65	0.360	9.851	1.01	0.079	7.760	24.07	1.768	7.346	3.10	0.260	8.387
B_B	431.5	11.83	0.190	1.606	3.60	0.065	1.798	0.843	0.048	5.709	25.87	0.982	3.796	2.75^{a}	0.084	3.037

*DM: dry matter, UC_B: untreated control variant alfalfa silage, A_B: alfalfa silage variant A, B_B: alfalfa silage variant B.
Values with identical superscripts within one column are significant at P<0.05
DM: suha tvar, UCB: netretirana kontrolna varijanta silaže djeteline, AB: silaža djeteline varijanta A, BB: silaža djeteline varijanta B
Vrijednosti s istim natpisom u jednom stupcu su značajne P<0,05

CONCLUSIONS

In the experiments we detected the influence of different silage additives and technology on the mineral contents in alfalfa. Wilting time postitive by affected calcium and magnesium contents ($P<0.05$), sodium content ($P>0.05$) and partially phosphorus content. In laboratory conditions conserved silages we found higher calcium, sodium and potassium content than in silages made in silage bag.

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SAŽETAK

Cilj ovog rada bio je određivanje odabranih makrominerala u silaži djeteline konzervirane različitim dodacima i tehnologijama skladištenja. Konzervirali smo djetelinu drugog otkosa, fenifaze cvjetanja. U pokusu smo konzervirali djetelinu u tri varijante (UC: netretirana kontrola, A: varijanta s dodatkom bakterija mliječne kiseline, B: varijanta s bakterijama mliječne kiseline i dodatkom složenih amilaza i hemicelulaza). Sve su varijante spremljene u silažne jedinice (SJ 750) i silažne vreće. Nakon završenog procesa fermentacije nismo našli značajne ($P>0.05$) razlike u sadržaju Ca, Na, i K u silažnim jedinicama SJ 750, a najviši sadržaj Ca otkriven je u kontrolnoj varijanti UC (13,68g/kg -1suhe tvari). Pozitivno djelovanje primjene dodataka nađeno je u sadržaju P (3,75 g/kg^{-1} suhe tvari) u varijanti B. Nakon primjene silažnih dodataka našli smo značajno niži ($P<0.05$) sadržaj Mg u silažnim jedinicama. Neznačajne razlike u sadržaju P,Na i K otkrivene su u silažnim vrećama. Najviši sadržaj Ca (12,22 g/kg^{-1} suhe tvari) ustanovili smo u varijanti A (dodatak bakterija mliječne kiseline). U varijantama A i B (primjena silažnog dodatka) našli smo viši sadržaj P.

U usporedbi s netretiranom kontrolom najviši sadržaj Mg ($P<0.05$) našli smo u varijanti s dodatkom bakterija mliječne kiseline (varijanta A).

U usporedbi varijanata uskladištenih u silažne jedinice i vreće otkrili smo značajno viši sadržaj Na u silažnim vrećama u kontrolnoj varijanti UC i u varijanti B ($P<0.05$).

Primjena silažnih dodataka može djelovati na sadržaj nekih minerala.To djelovanje je pozitivno sa stajališta hranidbe mineralima.

U laboratorijskim uvjetima konzerviranja silaže našli smo viši sadržaj kalcija, natrija i kalija nego u silažama u vrećama.

Ključne riječi: djetelina, silaža, dodaci, minerali, makroelementi