The Effect of Different Types of Inoculants on the Characteristics of Alfalfa, Ryegrass and Red Clover-Ryegrass-Timothy Silage

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The effect of different types of inoculants on the characteristics of alfalfa, ryegrass and red clover-ryegrass-timothy silage

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Introduction

Silage inoculants based on lactic acid bacteria (LAB) have demonstrated improvements in energy and nutrient recovery from grass and legume silages by lowering the pH and shifting the fermentation towards lactic acid production, by reducing storage losses due to spoilage and by increasing the aerobic stability during feed-out. There are different mixtures of strains currently on the market.

The present study was conducted according to the Deutsche Landwirtschafts-Gesellschaft Guidelines for the testing of silage additives in order to assess which mixtures of lactic acid bacteria would have a greater potential to improve fermentation profile of alfalfa, perennial ryegrass and red clover/ryegrass/timothy silages and whether they differ in their capacity to limit the extent of deterioration during exposure of the different silages to air.

Materials and Methods

The alfalfa, perennial ryegrass and red clover/perennial ryegrass/timothy forages were swathed, wilted and picked up, and chopped to about 20-mm length of cut. 5 samples of untreated chopped forage were taken for analysis of initial silage nutritional characteristics. In the laboratory, the forages were ensiled in 3.0- and 0.7-L (for determination pH 3 days after ensiling) anaerobic glass jars at density of 0.2 kg DM/L. The herbages were all ensiled either without inoculant (control silage) or with the addition of three commercial inoculants: Feedtech™ Silage F10 (*Pediococcus acidilactici* 33-11 NCIMB 30085, *P. acidilactici* 33-06 NCIMB 30086, *Lactobacillus plantarum* LSI NCIMB 30083, *L. plantarum* L- 256 NCIMB 30084, *Enterococcus faecium* M74 NCIMB11181, DeLaval), Feedtech™ Silage F22 (*L. plantarum* LSI NCIMB 30083, *L. plantarum* L-256 NCIMB 30084, *P. acidilactici* 33-11 NCIMB 30085, *E. faecium* M74 NCIMB 11181, *L. lactis* SR 3.54 NCIMB 30117, xylanase, sodium benzoate, DeLaval) and Bonsilage (*L. buchneri*, *P. pentosaceus*). All inoculants were applied to the forage following the label instructions. 10 microsilo's were prepared for each combination of herbage and inoculant, 5 for analysis of nutritional parameters and 5 for analysis of aerobic stability. All inoculants were diluted with distilled water so that they were applied at the same rate (4 ml of solution/kg of crop, sterile water for the control). Inoculant solutions were analyzed for LAB counts. Silos were stored for 90 days at room temperature (20°C), after which they were sampled for analysis of DM content, chemical composition, volatile fatty acid (VFA) content, lactic acid content, alcohol concentrations and aerobic stability. For each herbage type separately, silage composition data were analyzed using PROC MIXED and aerobic stability were analyzed using the log rank test of PROC LIFETEST of SAS (v 9.3). Bonferroni multiple comparison adjustments were made to the p-values for pair-wise comparisons of means. Significance was declared at $P< 0.05$.

Results and Discussion

Based on the water soluble carbohydrates (WSC) and crude protein (CP) content in combination with the buffer capacity of the herbages prior to ensiling, the alfalfa forage was considered as difficult to ensile (15 and 79 g/kg fresh matter of WSC and CP and 452 mEq/ kg DM buffer capacity), while perennial ryegrass and red clover/ryegrass/timothy forages were considered to be moderately easy to ensile (41 and 31, and 50 and 64 g/kg fresh matter of WSC and CP, and 270 and 280 mEq/kg DM buffer capacity, respectively). The inoculants improved the fermentation in all three silages, produced higher ($P<0.05$) concentrations of lactic acid and VFA, induced a bigger drop in pH while using less WSC ($P<0.05$) and reduced DM losses compared to the uninoculated control silages (Table 1). The slower decline in pH after ensiling and lower concentrations of fermentation products of spontaneous fermented silage compared to inoculated silage probably reflected the low epiphytic LAB counts and their less efficient lactic acid production compared to commercial strains as suggested by Davies *et al*., (2005). Feedtech™ Silage F10 and Feedtech™ Silage F22 inoculants gave lower ($P<0.05$) pH value 90 days after ensiling and produced more ($P<0.05$) lactatic acid in silages than Bonsilage. Bonsilage contains *L. buchneri*, a hetero fermentative LAB which is known to be less efficient in producing lactic acid than homo fermentative

LAB usually resulting in more acetic acid, higher pH, higher ethanol content and higher DM losses but increased aerobic stability (Filya *et al.*, 2007).

Table 1: Fermentation characteristics of the silages 90 days after ensiling, g/kg

		Control	**Feedtech Silage F10**	**Feedtech Silage F22**	**Bonsilage**
Alfalfa	pH 3 d	6.15^{b}	5.29^{a}	5.36^{a}	5.98^{b}
	pH 90 d	6.02^{c}	4.94^{ab}	4.85^{a}	5.01^{b}
	Lactic acid	25.63^{b}	55.89^{a}	56.23^{a}	47.78^{a}
	Acetic acid	18.40^{b}	23.80^{ab}	24.31^{ab}	29.66^{a}
	Butyric acid	5.30^{b}	1.00^{a}	0.96^{a}	1.75^{a}
	Alcohols	7.79^{b}	2.71^{a}	2.78^{a}	3.25^{a}
	NH3-N	96.07^{b}	56.16^{a}	60.57^{a}	58.44^{a}
	DM loss	84.48^{b}	41.15^{a}	48.70^{a}	61.69^{ab}
Perennial ryegrass	pH 3 d	4.71^{c}	4.31^{b}	4.18^{a}	4.35^{b}
	pH 90 d	4.31^{c}	4.04^{a}	4.00^{a}	4.20^{b}
	Lactic acid	38.68^{c}	64.95^{b}	97.84^{a}	64.67^{b}
	Acetic acid	25.03	29.10	33.84	33.45
	Butyric acid	2.58^{b}	0.54^{a}	0.85^{a}	1.67^{ab}
	Alcohols	6.10^{b}	3.29^{a}	3.87^{a}	5.5^{b}
	NH3-N	32.85^{b}	18.62^{a}	18.7^{a}	27.79^{b}
	DM loss	56.18^{b}	29.44^{a}	22.67^{a}	38.1^{ab}
Red clover/ ryegrass/timothy grass	pH 3 d	4.37^{c}	4.26^{ab}	4.17^{a}	4.36^{b}
	pH 90 d	4.37^{c}	4.06^{a}	4.00^{a}	4.13^{b}
	Lactic acid	37.10^{b}	57.94^{a}	60.44^{a}	42.29^{b}
	Acetic acid	24.25^{b}	16.58^{a}	15.89^{a}	18.75^{a}
	Butyric acid	2.56^{b}	0.41^{ab}	0.18^{a}	1.00^{ab}
	Alcohols	6.32^{c}	3.57^{a}	4.09^{ab}	4.41^{b}
	NH3-N	32.94^{b}	16.26^{a}	25.85^{b}	29.35^{b}
	DM loss	58.77^{b}	32.30^{a}	51.51^{b}	46.32^{b}

Calculated dry matter losses and fermentation parameters are corrected for volatiles. $^{a-d}$ Means within a row with unlike superscripts differ (P< 0.05).

Every inoculant improved the aerobic stability of alfalfa, perennial ryegrass and red clover/ryegrass/timothy silages significantly (P<0.05) when compared to the control silage (Fig. 1). F22 showed the best aerobic stability for all herbages.

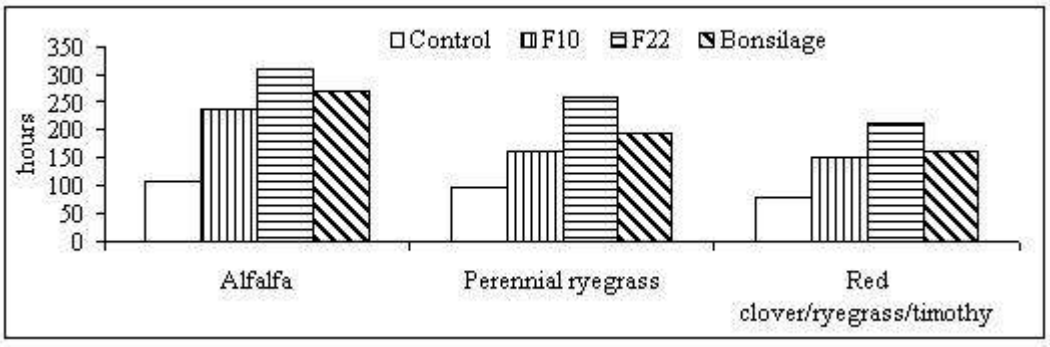

Fig. 1: Hours after oxygen exposure when aerobic stability was compromised[1]. [1-]Aerobic stability was considered compromised when silage temperature increased 3ºC above ambient temperature.

Conclusion

Inoculation did succeed in improving the alfalfa, perennial ryegrass and red clover/ryegrass/timothy silages characteristics, resulting in lower dry matter losses and better aerobic stability.

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