Sustainable Livestock Production in the Perspective of
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Fermentation Characteristics and Aerobic Stability of Triticale Silage Treated with Formic Acid or a Mixture of Formic and Propionic Acids

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ABSTRACT

This study was conducted to evaluate the effects of some organic acids as additive on chemical composition, fermentation characteristics and aerobic stability of whole-crop triticale silage. Triticale harvested in early dough stage, chopped at 20 mm length and ensiled in 4-L polyvinyl tubes for 45 days. Treatments were control (no additive), 4 L formic acid per ton of fresh forage and 4 L mixtures of formic acid and propionic acid (2:1) per ton of fresh forage. Silage treated with formic acid had higher dry matter content compared to other treatments. However, crude protein and NDF concentration of silages were not influenced by acid treatments. The pH value of silage treated with mixture of formic and propionic acid was lower than the control (4.48 vs. 4.70). Application of formic acid alone or in combination with propionic acid decreased ammonia nitrogen concentration of silages ($p<0.05$). Furthermore, aerobic stability of silage supplemented with mixture of formic and propionic acids was 1.6 times higher compared to control. The results indicate that ensiling triticale herbage with mixture of formic and propionic acids could improve some fermentation characteristics and aerobic stability of its silage.

Key Words: Triticale, Silage, Formic acid, Propionic acid, Aerobic stability

INTRODUCTION

Ensiling is a preservation method for most forage crops and fermentation take place in every silo might be uncontrolled process. The major goal in silage making is to preserve silage material with minimum nutrient loss (Sariçiçek and KILIÇ, 2009). In order to achieve this aim, chemical preservatives are used as preserving agents either separately or in combination with other acids (Dolezal et al., 2008). The addition of formic acid to crops has improved quality of silages and efficiency of preservation (Haigh, 1988, Arabi et al., 2008). However, propionic acid has the greatest antimycotic activity amongshort-chain fatty acids. It is effective in reducing yeast and molds which are responsible for aerobic deterioration in silages (Kung et al., 1998). The aim of this study was to assess the effects of formic and propionic acids as additive on chemical composition, fermentation characteristics and aerobic stability of whole-crop triticale silage.

MATERIALS AND METHODS

General: Whole crop triticale harvested in early dough stage, chopped at 20 mm length and ensiled in 4-L polyvinyl tubes for 45 days. Treatments were control (no additive), 4 L formic acid per ton of fresh forage and 4 L mixtures of formic acid and propionic acid (2:1) per ton of fresh forage. Silage samples from each silo were evaluated for DM content by drying duplicate samples for 48 h in a forced-air oven set at 60°C.Crude protein (CP) was determined according to the Kjeldahl procedure (AOAC) by the Tecator Auto-Analyzer. The concentration of neutral detergent fiber (NDF) was determined according to Van Soest et al. (1991). Water extracts were prepared from ensiled samples by mixing 50 g of forage with 50 mL of deionized water and homogenizing this mix for 1 min. Then, silage pH was determined using a portable pH meter. A portion of water extracts were filtered through four layers of cheesecloth and 10 ml of it acidified with 10 ml of 0.2 N HCL. Ammonia nitrogen

(NH_3-N) concentration of acidified silage extracts were determined using distillation method. Aerobic stability was determined on all silages after silo opening. Two Kg samples of each replicate from each treatment were placed loosely into clean, 20L buckets. Silages were exposed to air at room temperature (22°C) and thermometers were placed in the center of the silage masses. A double layer of cheesecloth wasplaced over each container to prevent drying and contaminationbut allowing penetration of air. Ambient temperature and the temperature from each silagewere recorded every 2 h. Temperatures were monitored for several days. Aerobic stability was defined as the number of hours the silage remained stable before rising more than 2°C above the ambient temperature (Moran et al., 1996).

Statistic: Statistical analysis was performed using GLM procedure of SAS. The model used for the analysis was Yij = μ + Ti + eij, where Yij was the dependent variable; μ was the population mean for the variable; Ti was the effect of treatment i; eij was the random error associated with the observation ij. Treatments were compared with control using the Tukey test at P= 0.05.

RESULTS AND DISCUSSION

Chemical characteristics of experimental silages are presented in Table 1. Silage treated with formic acid had higher DM content compared to other treatments. This finding is confirmed increasing effect of formic acid on dry matter content of silage which has reported in some of former studies (Chamberlain et al. 1982, Baytokand Muruz, 2003).

Table 1. Chemical composition of untreated and treated whole crop triticale silages

Item	Experimental Treatments[1]			SEM	P-value
	control	Formic	Formic + Propionic		
DM	15.38[b]	17.25[a]	15.65[b]	0.1	<0.001
CP (g kg DM^{-1})	220	210	220	5.9	0.08
NDF (g kg DM^{-1})	440	470	470	2.3	0.55
pH	4.70[a]	4.68[a]	4.48[b]	0.04	0.009
NH3-N(mg dL^{-1})	1.30[a]	0.77[b]	0.73[c]	0.02	0.001

[1]Control: untreated triticale silage (no additive), Formic: triticale silage treated with 4 L formic acid per ton of fresh forage, Formic + Propionic:triticale silage treated with 4 L mixtures of formic acid and propionic acid (2:1) per ton of fresh forage

[a, b, c]Means within the same row having different letters are significantly different ($p < 0.05$)

CP concentrations of silages were not influenced by treatments. Aksu et al. (2006) and Jaakkola et al. (2006) also observed no effect of supplementation of organic acid on CP content of cereal silages.Furthermore, ensiling with using acidsdid not affect NDFconcentrations of silages.The pH value of silage treated with mixture of formic and propionic acid was lower than the control. In contrast to our results, in study ofNadeau (2007) application of the mixture of these short chain organic acids did not alter pH value of triticale silage compared to the untreated silage. This difference could be due to the lower DM content of triticale at ensiling in our study because by increasing DM of whole crops, their fermentationextent during ensiling process is changed (Naidu, 2007).Application of formic acid alone or in combination with propionic acid decreased NH3-N concentration of silages. Consistent to our results, some of former researches also reported a reductive effect of formic and propionic acidson NH3-N concentration of triticale silage (D'Urso et al. 1990, Naidu, 2007). Supplementation of silages with mixture of formic and propionic acidscaused 1.6 times increment in their aerobic stability (Figure 1.).

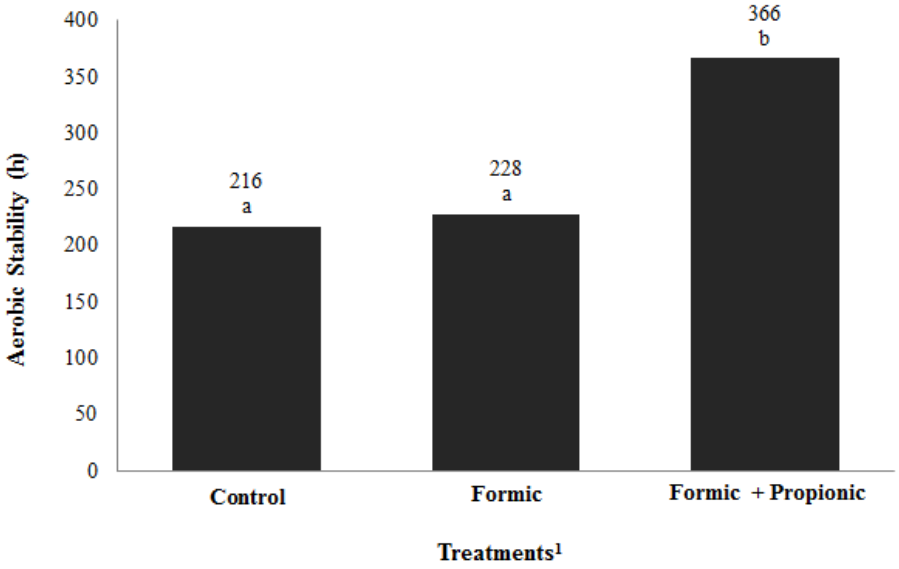

Figure 1. Aerobic stability of untreated and treated whole crop triticale silages

[1]Control: untreated triticale silage (no additive), Formic: triticale silage treated with 4 L formic acid per ton of fresh forage, Formic + Propionic: triticale silage treated with 4 L mixtures of formic acid and propionic acid (2:1) per ton of fresh forage

Propionic acid has stimulatory effects on silage fermentation to produce more lactic acid and decrease the number of yeasts and therefore, could improve aerobic stability of silage (Kung and Ranjit 2001). The results of this study indicate that ensiling triticale herbage with mixture of formic and propionic acids could improve some fermentation characteristics and aerobic stability of its silage.

CONCLUSION

The results indicate that ensiling triticale herbage with mixture of formic and propionic acids could improve some fermentation characteristics and aerobic stability of its silage.

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