EFFECTS OF BIOLOGICAL ADDITIVES ON SILAGE COMPOSITION OF MOTT DWARF ELEPHANTGRASS AND ANIMAL PERFORMANCE

Efecto de Aditivos Biológicos sobre la Composición de Ensilaje de Pasto Elefante Enano cv. Mott y el Rendimiento Animal

Tyrone Clavero y Rosa Razz

Centro de Transferencia de Tecnología en Pastos y Forrajes, Universidad del Zulia. Apdo 15098. Maracaibo 4005, estado Zulia, Venezuela.

ABSTRACT

This experiment was conducted to study the effects of cellulase enzymes and lactic acid bacteria on the fermentation characteristics, chemical composition, nutritive value and animal performance of *Pennisetum purpureum* cv. Mott silage. Five kinds of preparation were made: sugar molasses (control), sugar molasses and cellulase enzymes, cellulase enzymes, concentrate of lactic acid bacteria and sugar molasses and concentrate of lactic acid bacteria. Significant differences (P<0.05) were found in fermentation quality and chemical composition between control and the biological additives treated silage. Addition of cellulase enzymes and lactic acid bacteria resulted in decreased of pH value, cell wall content and increased lactic acid concentration. The biological additives increased silage intake and live weight by growing steers.

Key words: *Pennisetum purpureum* cv. Mott, silage, biological additives.

RESUMEN

Un experimento fue conducido para estudiar los efectos de enzimas de celulosa y bacterias de ácido láctico sobre las características de fermentación, composición química, valor nutritivo y rendimiento animal de ensilaje de pasto elefante enano cv. Mott. Se realizaron cinco preparativos: melaza (control), melaza y enzimas de celulosa, enzimas de celulosas, concentrado de bacterias de ácido láctico y melaza y concentrado de bacterias de ácido láctico. Se encontraron diferencias significativas (P<0,05) en la composición química y en la calidad de fermentación entre el control y los tratamientos donde se aplicaron los aditivos biológicos en el ensilaje. La adición de enzimas de celulosa y bacterias de ácido láctico resultó en una disminución de los valores de pH, contenido de pared celular e incrementaron las concentraciones de ácido láctico. Los aditivos biológicos incrementaron el consumo de ensilaje las ganancias de peso diario en novillos en crecimiento.

Palabras clave: *Pennisetum purpureum* cv. Mott, ensilaje, aditivos biológicos.

INTRODUCTION

Cattle production based on the maximum utilization of pastures and forages requires necessarily, an adequate grassland management policy. During the last two decades different aspects in respect to grassland management have been studied in tropical conditions. One of these practices is the use of biological and chemical additives to improve fermentation characteristics and silage quality [9].

Dwarf elephantgrass (*Pennisetum purpureum* cv. Mott) is a tropical perennial bunchgrass usually managed by grazing or cut and carry. In tropical dry conditions to insure the availability for the grass throughout the year, the grass is conserved as silage. The grass contains a high moisture which affect the silage fermentation. An increasing number of studies [5, 15] have been reported positive benefits of biological conservation agents on silage quality.

The objectives of this silage study were to determinate if dwarf elephantgrass could be adequately preserved as silage using biological additives and the conversion of dwarf elephantgrass silage into animal products.

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MATERIALS AND METHODS

Location of the experimental area

The experimental was conducted in a farm located in western region of Venezuela with climate and vegetation corresponding to a tropical dry forest, with an average annual temperature of 29°C and rainfall between 1200 and 1400 mm with bimodal distribution. Soil are of flat topography with a slight slope, the textures varies from sandy to claying loam and present a sub-superficial claying horizon at a depth varying from 0 to 50 cm with a pH of 5.5 to 6.5 [4].

Preparation of silages

Fully established stands of "Mott" dwarf elephantgrass was staged to a 15 cm stubble. Nitrogen (150 kg/ha) was applied immediately after harvesting. Plants were harvested mechanically at 6 weeks (the dry matter content was 19.4%) regrowth, chopped into 1 to 2 cm particles and ensiled without wilting in rectangle concrete bunkers (capacity approx. 1000 kg) closed at one end with permanent ramp and at the other end with movable boards, covered and sealed with black polythene film. After grass was harvested, representative subsamples were taken for chemical analysis. The chemical composition and in vitro dry matter digestibility of the grass is shown in TABLE I.

Additives were used at the time of ensiling by spraying them on the forage into the silo.

The following kinds of additives were used:

- Sugar molasses (sources of sacharose) (Control) at 5% with a dry matter content of 79.2%
- Sugar molasses and cellulase enzymes (SMF) at 1:1 ratio
- Cellulase enzymes (F) at rate of 0.01% fresh forage
- Concentrate of lactic acid bacteria (B), application rate 1 x 10^{10} cfu.g^{-1} fresh sample forage
- Sugar molasses and concentrate of lactic acid bacteria (SMB) at 1:2 ratio
- Three silages were made for each treatment. After the incubation period, silos were opened after a 90 day storage period and the top layer of each silage was discarded before sampling. The samples were collected and kept frozen until used for further analysis.

Chemical analysis

Samples of silages were analyzed pH, dry matter content (DM), chemical composition (carried out according to Van Soest and Wine, 1967), crude protein using Micro-Kjeldahl technique [1] and organic acids were determined by gas chromatography [12].

TABLE I
THE CHEMICAL COMPOSITION AND *IN VITRO* DRY MATTER DIGESTIBILITY OF MOTT DWARF ELEPHANTGRASS MATERIAL PRIOR TO ENSILING

Composition	Contents
Dry matter (%)	19.40
Crude protein (%)	13.10
NDF (% DM)	66.46
ADF (% DM)	42.20
WSC (% DM)	6.02
IVDMD (%)	61.92

NDF= Neutral detergent fiber. ADF= Acid detergent fiber. WSC= Water soluble carbohydrate. IVDMD= *In vitro* dry matter

Feeding trial

The silages were evaluated using for each of the treatments 12 growing Brahman steers, their average body weight was 312 kg. The experiment covered 14 weeks of which 2 weeks were used for observation. During this period the steers were adjusted to the experimental feeds and observed as their general suitable for the experiment.

Dietary forages consisted of 50% of fresh dwarf elephantgrass and 50% silages. Feeds were given at 2.25% of the body weight daily on dry matter basis. All animals had free access to mineral salt and water, and treated against internal and external parasites.

The animals were weight individually at 14 days intervals after overnight fasting. Daily liveweight gains and silage intake were measured.

Statistical analysis

The data were subjected to analysis of variance as a randomized block design and statistical significance among treatments means was determined by Duncan´s test [11].

RESULTS AND DISCUSSION

The chemical and fermentation characteristics on the silage are shown in TABLE II. The quality of the silages were generally good. All silage treated with biological additives were well preserved as indicated by their low pH values, high lactic acid concentrations and low butyric acid levels. Mean pH values recorded for all silages range narrowly (4.91-4.09). Highest pH values were consistently obtained from control, which showed the lowest levels of lactic and acetic acids. There no mark differences were found in crude protein between control and silages treated with biological additives. There were no significant differences in crude protein between control (10.1%), SMF (10.8%), F (10.6%), B(10.8%) and SMB (10.8%).

TABLE II
CHEMICAL COMPOSITION AND FERMENTATION CHARACTERISTICS OF SILAGES

Chemical composition	Silage type				
	Control	SMF	F	B	SMB
pH	4.91[a]	4.27[a]	4.39[a]	4.11[a]	4.09[a]
DM (g/kg)	185[b]	211[a]	208[a]	28.1[a]	217[a]
Crude Protein (%DM)	10.1[a]	10.8[a]	10.6[a]	10.8[a]	10.8[a]
NDF (%DM)	65.3[a]	55.1[b]	57.8[b]	61.8[ab]	60.1[ab]
ADF (%DM)	40.2[a]	33.6[b]	36.5[ab]	37.4[ab]	36.3[ab]
Hemicellulose (%DM)	28.1[a]	21.4[b]	22.5[b]	24.3[b]	25.2[ab]
Acid Content (g/kg DM)					
Lactic	45.6[d]	145.1[ab]	126.7[c]	166.7[a]	187.2[a]
Acetic	72.8[c]	81.2[b]	79.5[c]	96.5[a]	101.4[a]
Propionic	41.6[a]	17.2[b]	19.1[c]	14.1[bc]	12.5[c]
Butyric	25.9	–	–	–	–

Values on the same line with different superscripts are different, Duncan Test (P<0.05)

The use of preparation with the content of cellulase enzymes caused an increased degradation of plant cell wall constituents that were more susceptible to bacterial decomposition. These results are consistent with those of Ridla and Vehida [6] and Sajko *et al*. [8], who reported that cellulase enzymes addition was capable to breakdown the component of structural carbohydrates during ensiling and improving fiber degradation during silage fermentation. Much research has shown an improvement in cell wall degradation by enzyme inclusion during silage fermentation [3,10]. It might be due to more substrate of fermentable carbohydrates were provide from the hydrolysis of cell wall components, which stimulate a good fermentation by lactic acid bacteria. In contrast, Ridla and Uchida [7] reported that applying microbial inoculant to *Chloris gayana* and *Lolium multiflorum* had no effect on the degradation of cell wall components, since there were no changes in NDF and ADF contents between the untreated controls and lactic acid bacteria treatments.

Lactic and acetic acids are major components of fermentation that are responsible for the increase in acidity of ensiled biomass [2, 14]. In the present study, silages treated with lactic acid bacteries resulted in highest amount of organic acids and lowering final pH value improved the qualitative parameters of the silage compared with control. The silages treated with biological additives had also lower cell wall components (NDF, ADF) than silages control. These results are consistent with Zhang *et al*. [16] who reported that enzymes addition improved fermentation quality of silages.

The control treatment showed the highest moisture content, moderate final pH and levels of butyric acid would suggest some clostridial activity.

Addition of both biological additives increased dry matter content of silage and accelerated initial lactic acid fermentation by increasing substrate for lactic acid producing microbes.

TABLE III gives mean silage intake and liveweight gains by growing steers. Summarized results of feeding trial indicate that biological additives affected silage consumption. Overall there was a slight increase in silage intake and daily weight gains (DWG) with the biological additive treated compared with the control.

This experiment suggest that silage intake and DWG are limiting by factors like increased water concentration of diet, low fiber digestibility and concentrations of butyric acid. Ruiz *et al*. [8] observed reduction in intake with each increase in NDF concentration and estimed decline in DMI about 0.02 kg/100 kg of BW for each 1% moisture in diet.

CONCLUSION

The results showed in this research indicates the possibility of altering the fermentation of silage of dwarf elephantgrass with biological additives so as to increase its utilization by growing steers. Further studies on preservation methods with another biological additives and other fodder are needed.

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TABLE III
SILAGE INTAKE AND DAILY WEIGHT GAINS (DWG) IN GROWING STEERS

	Silages type				
	Control	SMF	F	B	SMB
Silage intake (kg DM/d)	2.45[b]	3.12[a]	3.15[a]	3.16[a]	3.20[a]
DWG (kg/d)	0.65[b]	0.69[ab]	0.71[a]	0.73[a]	0.75[a]

Values on the same line with different superscripts are different, Duncan Test (P<0.05).

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