Organic Acid Preservation Of Waterhyacinth Silage[1,2]

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ABSTRACT

Acetic acid (A), formic acid (F), and a commercial product (PA)[3] containing 80% propionic and 20% acetic acid by weight were individually evaluated at high (H), 0.5%, and low (L), 0.25%, levels to determine their effect on ensilability of chopped, pressed waterhyacinth [*Eichhornia crassipes* (Mart.) Solms] and voluntary intake by cattle of acid-treated waterhyacinth silage (WHS). Preservation of ensiled waterhyacinth, as evaluated by silage acidity, temperature profile, and degree of spoilage, was acceptable for all acid treatments. Voluntary intake of silage treatments improved as lactic acid concentration increased and pH decreased. Treatments high CHEMSTOR (HPA), low CHEMSTOR (LPA), and high formic acid (HF) were more acceptable ($P<.05$) to cattle than low formic acid (LF), control (C), high acetic acid (HA), and low acetic (LA) silage.

INTRODUCTION

Feeding of fresh waterhyacinth to livestock is limited by its extremely high moisture content, rapid deterioration, and spoilage (4,6). Processed waterhyacinth has been fed to cattle as dried pressed residue, whole dried chopped plants, and in pelleted forms with various supplements (8,9,10). Formic, acetic, and propionic acids have been shown effective as preservatives for ensiling high moisture land crops (9). The objectives of this study were to determine the effects of two levels of these three organic acids on ensilability of chopped, pressed waterhyacinth, and voluntary feed intake by cattle of acid-treated waterhyacinth silage.

METHODS AND MATERIALS

Waterhyacinth plant material used in this study was collected at the Alachua sink and classified (2) as whole plants with less than 1% float petiole, chopped 1.5 cm, wet press residue, maximum 15% ash, minimum 9% crude protein. It was harvested and chopped in a Leach harvester-chopper and pressed in a Vincent press (1.2 kg/cm^2, 49 rpm) to reduce the moisture content to 87.5% (1). Silage was made in 208-liter laboratory silos fitted with plastic liners and lids and capped with a sealing ring (1). Silos were equipped with thermocouples to monitor temperatures and drains to collect effluent.

Control silage (C) contained 5 kg dried citrus pulp (DCP) and 1 kg standard sugarcane molasses (SCM) per 100 kg chopped, pressed waterhyacinth. All acid treatments consisted of control silage plus added levels of acetic, formic or a propionic-acetic mixture (Table 1). Silos were opened after 60 days and silage was weighed, spoilage was removed and weighed. Edible silage was placed in large barrels lined with plastic bags and stored at 3 to 5 C until fed. Acidity (pH) was measured in fresh material and effluent collected during the first 30 days. Dry matter (DM), ash, volatile fatty acids (7) and lactic acid (3) were determined. Six yearling Hereford x Angus crossbred steers, averaging 253 kg, were used to determine differential silage palatability. Measured quantities of the seven silage treatments were placed in separate feed containers in such a manner as to assure ad libitum access to each treatment. Quantities consumed during the following 7 days were used for ranking treatments relative to palatability.

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[3]CHEMSTOR, Celanese Agricultural Products Group, 7733 Forsyth Boulevard, St. Louis, Missouri 63105.

TABLE 1. COMPARATIVE SILAGE TREATMENT AND COMPOSITION.

Characteristics	Control	High propionic acid	Low propionic acid	High formic acid	Low formic acid	High acetic acid	Low acetic acid
WHPR[a], %	100	99.50	99.75	99.50	99.75	99.50	99.75
CHEMSTOR[b], %		0.50	0.25				
Formic acid[c], %				0.50	0.25		
Acetic acid[d], %						0.50	0.25
Dry matter, (DM) %	17.04	18.30	18.87	17.20	18.47	17.89	18.41
Spoilage (%DM)	17.8	10.8	16.0	17.0	28.7	15.1	13.0

[a] Waterhyacinth press residue (WHPR), 100 kg WHPR:5 kg citrus pulp:1 kg standard sugarcane molasses.
[b] Commercial product, 80% propionic acid, 20% acetic acid.
[c] Technical grade, 88% guarantee.
[d] Laboratory grade, 99.8% guarantee.

RESULTS AND DISCUSSION

Effluent pH and silage temperature indicated that the waterhyacinth was ensiled within 12 days. Control silage had mold interspersed throughout the silage. Only a very small quantity of mold was found on the surface of acid-treated silages which is consistent with reports on acid-treated land crops (9).

Steers offered only waterhyacinth silage during a 7-day feeding period showed definite preferences among silage treatments (Table 2). The HPA, LPA, and HF were consumed in greater quantities (P<.05) than LF, C, HA, and LA treated silages. Intake of all treatments for the 7-day period was 7.58 kg per head per day as fed and 1.37 kg per head per day on a dry matter basis. Palatability increased as silage lactic acid and total organic acids increased and pH decreased. The pH values for acid-treated and control waterhyacinth silages were similar to pH values reported for acid-treated ensiled land forages (9). Highest lactate and total organic acid levels were found in silages having lowest pH which was also reported with acid-treated ensiled land forages (9).

Mechanical drying and further processing of harvested chopped pressed waterhyacinth residue has not been economically feasible; therefore, utilization of waterhyacinth as silage appears probable. High moisture content, averaging 95%, has been the major obstacle in preserving waterhyacinth as silage. In this study, chopped press residue averaging 88% water content was preserved satisfactorily by acid treatments. Previously, waterhyacinth has been ensiled satisfactorily by adding 5% dried citrus pulp and 1% standard sugarcane molasses to the fresh chopped press residue, but a silo structure was required for fermentation. In this study, addition of organic acids effectively preserved waterhyacinth as silage thereby indicating the possibility of making waterhyacinth silage in stacks adjacent to a harvest site without construction of a permanent silo.

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TABLE 2. CHARACTERISTICS OF SILAGE TREATMENTS RANKED ACCORDING TO ACCEPTABILITY BY CATTLE.

	Silage Treatments						
Characteristics	High propionic acid	High formic acid	Low propionic acid	Low formic acid	Control	High acetic acid	Low acetic acid
Acceptability ranking[a]	1	2	3	4	5	6	7
Total dry matter intake during 7 days (kg)[b]	12.12[a]	11.33[a]	10.56[ab]	7.67[b]	5.78[c]	5.05[c]	4.85[c]
pH at day 12	4.23	4.25	4.30	4.39	4.42	4.47	4.53
Lactic acid, % of DM	24.80	19.74	19.24	17.72	15.54	14.75	6.71
Acetic acid, % of DM	1.60	1.84	2.12	1.72	2.02	2.02	2.41
Propionic acid, % of DM	1.50	0.79	0.42	0.77	1.04	1.04	0.87
Butyric acid, % of DM	1.44	1.62	1.87	1.52	2.26	2.26	2.22
Total organic acids, % of DM	29.34	23.99	23.65	21.73	20.86	20.86	12.21
Ash, % of DM	10.63	10.68	11.32	10.73	11.53	10.83	11.33

[a] Ranked by cattle consumption, 1 = most consumed, 7 = least consumed.
[b] Values having like superscript are not significantly (P<.05) different.

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