ENSILING OF SUGAR CANE WITH AMMONIA MOLASSES AND MINERAL ACIDS

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Summary

Chopped sugar cane stalk was ensiled for 49 days in 15 litre bins: alone, with additional bagasse, ammonia, ammonia and molasses or ammonia, molasses and mineral acids. In the untreated sugar cane, and the treatment containing bagasse, there was a considerable loss of sugars, converted in part into alcohol (5.5% in DM on the untreated sugar cane) and organic acids. In the silos containing added ammonia there was negligible loss of total sugars, although a high proportion of the sucrose was hydrolysed to reducing sugars. In the ammonia treated silages there was no alcohol, however lactic acid was relatively low (less than 1%). Final pH was high on the sugar cane ensiled with ammonia and ammonia/molasses, and there appeared to be some advantages from inclusion of mineral. acids which led to a final pH of 4.6. Addition of ammonia increased by a factor of 2 to 3 the amount of non ammonia nitrogen in the final ensiled product.

Key words: Sugarcane, ensiling, ammonia

Introduction

The justification for ensiling sugar cane relates in part to the problems associated with harvesting this crop in the wet season, and the fact that its nutritive value is higher when it reaches maturity (Banda and Alvarez 1976, Alvarez and Preston 1976), which usually coincides with the dry season. Thus in a situation where year round drylot feeding was practised, there would appear to be advantages from harvesting sugar cane at its optimum nutritive value in the dry season and conserving it for use in the wet season.

An additional reason for examining the possibility of ensiling sugar cane is that a controlled fermentation under anaerobic conditions might be a means of improving nutritive value through an increase in true protein content (by microbial growth) and lactic acid concentration. Increased concentrations of both these nutrients have been reported in whole crop maize, as a result of using additives and were associated with an improvement in feed utilization efficiency when such treated silage was fed to cattle (Henderson and Geasler 1970).

Work carried out so far on the ensiling of sugar cane has been discouraging . James (1973) compared fresh and ensiled derinded sugar cane and reported that voluntary intake was reduced by one third with a corresponding deterioration in live weight gain and feed conversion in the cattle fed the ensiled material. He attributed the poorer performance to production of acetic acid in the ensiled sugar cane having a negative effect on voluntary intake.

Unlike in conventional forages, which have only low concentrations of soluble,sugars, the microflora found on sugar cane appears to be predominated by yeasts which under anaerobic conditions at low pH have the capacity to metabolize sugars to alcohol. It is therefore possible that the poorer results associated with the ensiling of sugar cane might be attributed, not so much to acetic acid but more probably to formation of alcohol . This is not, a problem on other forages, e.g. maize, which has only 3 to 4% of sugars on a dry matter basis, so that substrate limitation helps to prevent,alcohol formation,

It is widely known that if sugars are fermented in the presence of adequate amounts of nitrogen, then less alcohol is' formed since the environment is then more favourable to the growth of the yeast itself. Addition of a nitrogen source is one possibility therefore to reduce alcohol production; it was also thought that if the initial pH in the ensiled material was higher, this also would favour bacteria rather than yeast organisms .

The objective of the experiment described here was to examine some of the end products of the ensiling,bf sugar cane amd to attempt to modify these,by incorporation of nitrogen in the form of ammonia. The solubility of ammonia in diluted molasses was also determined.

Materials and Methods

Trial 1:

Treatments:

The treatments are described in table 1. The additives were dry bagasse (with the aim of reducing the moisture content of the ensiled material), aqueous ammonia, ammonia mixed with molasses and ammonia mixed with molasses and mineral acids. Ammonia was chosen as a nitrogen source which would also raise pH in the initial stages of fermentation; the mineral acids were included in an attempt to improve the stability of the ammonia/ molasses mixture.

Procedure:

Sugar cane stalk was ground finely (particles of less than 5 mm) and mixed with the various additives. The mixed material was packed in 15 litre plastic containers which were sealed tight in order to ensure anaerobic conditions. The experimental silages were kept at ambient temperature (approximately 25°) for 49 days. Samples were taken of the fresh cane and the different mixtures before ensiling and after the 49 day conservation period.

Measurements:

Analyses were made of pH, total and reducing sugars; lactic acid, alcohol, total nitrogen and ammonia nitrogen. The methods were those AOAC (1970).

Table 1: Composition of experimental silos

	Fresh cane	No additive	Bagasse	Aqueous ammonia	Ammonia molasses	ammonia molasses mineral acids
Chopped stalk	100	100	84.4	97.92	96.06	96.30
Bagasse (day)			15.6			
Molasses					1.90	1.57
NH_4OH[1]				2.08	2.04	1.94
H_2SO_4						.11
H_3PO_4						.85

[1] Contains 28% NH_3

Trial 2:

The objective was to determine the saturation point of gaseous ammonia in diluted solutions of molasses, with and without mineral acids. The basic solutions contained (by weight): (A) 61% molasses , 39% water, and (B) 57% molasses, 30% water, 4% H_3PO_4 , 2% H_2SO_4. Anhydrous ammonia was then bubbled through two tanks of each of these solutions, one held at 20° and the other at 30°, until the saturation points were reached. The amount of ammonia remaining in solution was then determined.

Table 2:
Analysis of chopped sugarcane after ensiling with ammonia alone or plus molasses and mineral acids

		Ensiled cane with				
	Fresh cane	No additives	Bagasse	Aqueous ammonia[1]	Ammonia and molasses[2]	Ammonia, molasses mineral acids[3]
pH	5.4	3.4	3.65	7.70	6.17	4.65
Total sugars	44.4	31.1	28.4	41.3	42.2	43.2
Reducing sugars	4.08	3.58	1 .14	12.7	20.9	29.2
Sucrose	40.7	27.5	27.3	28.6	21.3	14.0
Alcohol	0	5.49	3.22	0	0	0.8
Lactic acid	0	1.34	.67	.95	.64	.74
Total N	.107	.187	.216	1.44	1.31	1.29
Protein N	.093	.183	.213	.393	.497	.477
Ammonia N	.024	.004	.003	1.05	.812	.816

Contained

[1] 2.08% aqueous NH4PH (28 a NH3)

[2] 1.94% NH_4OH, 1.57% molasses, .11% H_2SO_4 and .085% H_3PO_4

[3] 2.04%NH_4OH and 1.90% final molasses

Results and Discussion

Trail 1:

The analyses on the different silages are given in table 2 while the makeup of the N fraction is illustrated in figure 1.

The principal change occurring in the sugar cane ensiled without additives was the conversion of sucrose into alcohol and organic acids (only lactic acid was measured in this experiment). This process was not affected materially by inclusion of bagasse.

The incorporation of ammonia resulted in the conservation of almost all the sugars, eliminating completely the formation of alcohol. Addition of ammonia also led to increases in non-ammonia nitrogen (presumably amino nitrogen), indicating considerable microbial growth. There was a suggestion that this process was improved by the simultaneous inclusion of molasses. Addition of ammonia led to hydrolysis of some of the sucrose to reducing in sugars, this was enhanced by addition of molasses and still further when additional mineral acids were included. However, there was no effect on the concentration of total sugars which remained almost the same on all the different treatments containing ammonia.

In general, lactic acid levels were lower than are found normally in most ensiled forages, particularly maize, where values as high as 8 to 12% have been found with use of ammonia and molasses (Henderson and Geasler 1970).

The final pH of 7.7 in the sugar cane ensiled with aqueous ammonia would appear to be undesirably high, as was that for the addition of ammonia plus molasses. In this respect, the combined additives of molasses, ammonia and mineral acids appear to give the best combination of end products.

Trial 2:

Table 3 shows the composition of the solutions, saturated with ammonia, with and without mineral acids and at temperatures of 20° and 30°.

Solubility of ammonia was higher at the lower temperature, and not affected significantly by inclusion of mineral acids.

Table 3:
Solubility of anhydrous ammonia with or without mineral acids in diluted molasses at 20° or 30°

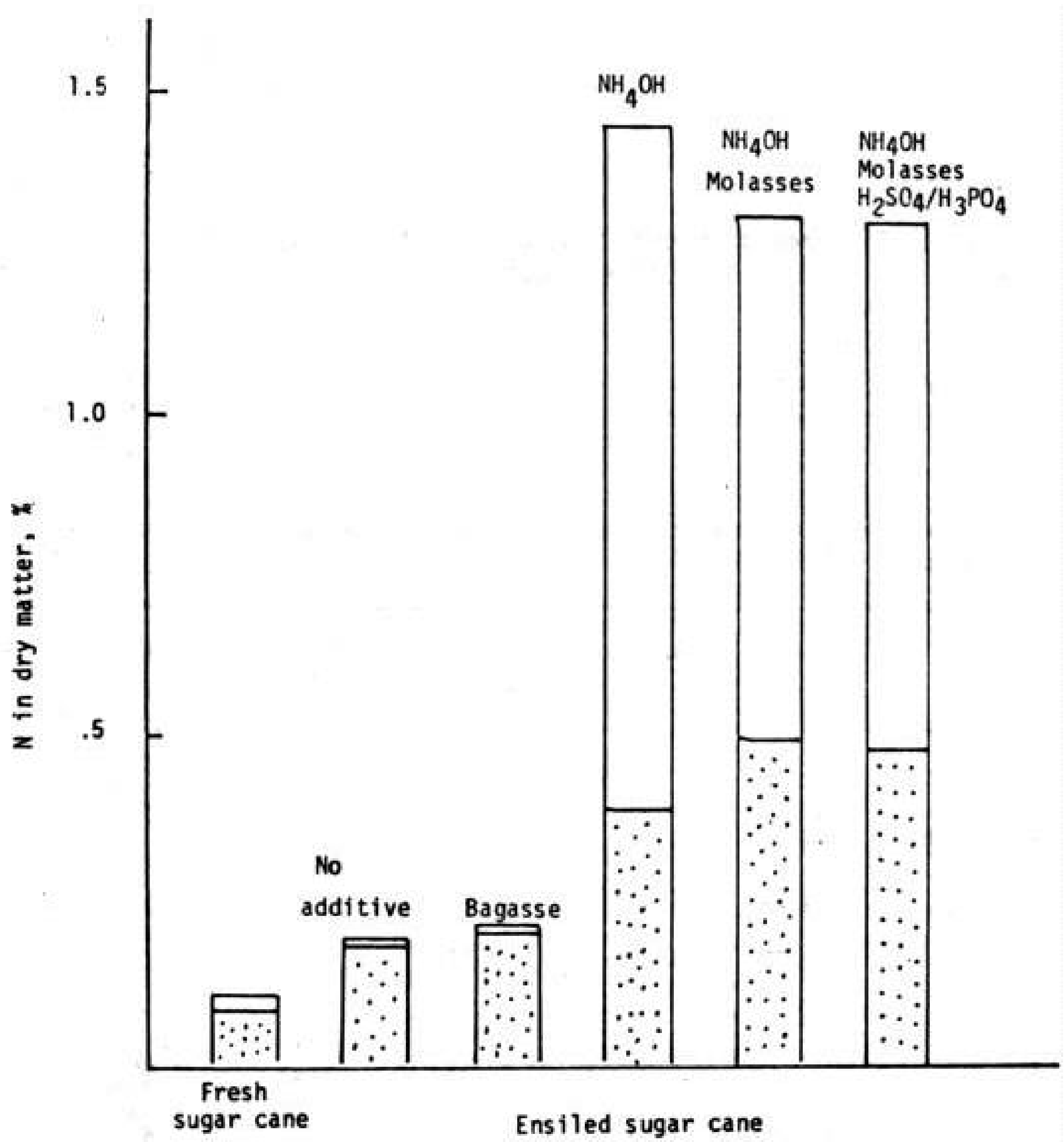
	Molasses	Water	Anhydrous Ammonia	H_3PO_4 (85 %)	H_2SO_4 (98.1%)
			% by weight		
Without acids					
20° C	53.03	33.90	13.07	-	-
30° C	55.75	35.85	8.60	-	-
With acids					
20° C	49.22	31.15	13.95	3.61	2.09
30° C	51.66	32.70	9.68	3.79	2.19

Conclusions

The results of this experiment show the advantages to be gained from adding ammonia to sugar cane at the time of ensiling, as a mean of maintaining the original sugars present in the cane and preventing their conversion to alcohol which occurs to a considerable degree when sugar cane is ensiled alone. There were also important increases in content of amino nitrogen which was increased by a factor of two to three compared with the untreated sugar cane.

For use in tropical conditions, a suitable ammonia/molasses mixture would contain: molasses 53, water 34 and anhydrous ammonia 13 (parts by weight).

Figure 1 :
Effect of ensiling chopped sugar cane stalk with various additives on ammonia N (□), non-ammonia N (::) and total N (total column weight)



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