AMMONIA/MOLASSES AND UREA/MOLASSES AS ADDITIVES FOR ENSILED SUGAR CANE

F J Alvarez and T R Preston

Centro de Investigación y Experimentación Ganadera
Chetumal, Mexico

Summary

Chopped sugar cane stalk was ensiled in four litre sealed jars with solutions containing either 34% aqueous ammonia (28% NH_3) and 66% molasses or 17% urea, 17% water and 66% molasses, at levels of 0, 20, 40, 60 or 80 ml/kg of fresh cane. Six jars were prepared on each subtreatment one of them being opened on days 0, 2, 5, 10, 20 and 40. Ammonia had a marked effect on the pH pattern during ensiling, with initial values of 10 falling to between 3.5 and 4.5, the rate of fall being inversely related to the concentration of ammonia; pH with urea was only slightly higher that in the control silage with no additives. Ammonia was much more effective in reducing the loss of sugars during the ensiling process. The most effective ammonia level appeared to be the equivalent of 1.6 g N/kg of cane, assessed in terms of minimum loss of sugar and maximum lactic acid concentration. At hither levels of ammonia inclusion, lactic acid content decreased. In contrast, the most advantageous level of urea was the highest one (equivalent to 30.6 g urea/kg of fresh cane). Acetic acid decreased with addition of ammonia but was little affected by urea. Butyric acid was found in only a few of the samples.

Key words: Sugarcane, ammonia urea, ensiling

Introduction

The justification for ensiling sugar cane relates in part to the problems associated with harvesting of sugar cane in the wet season and the fact that its nutritive value is higher when it reaches maturity (Banda and Valdez 1976) which usually coincides with the dry season. Thus, in a situation where year round dry lot feeding was practised, there could be a reason for harvesting sugar cane in the dry season, at its optimum nutritive value, and conserving it for use in the wet season.

The other argument in favour of ensiling sugar cane is that a controlled fermentation under anaerobic conditions may be a means of improving nutritive values by increasing the content of true protein (by microbial sinthesys) and of lactic acid. Both of these factors have led to improvements in feeding value of whole crop maize ensiled with additives (Henderson and Geasler 1970).

Results reported by James (1973) on the use of ensiled derinded sugar cane were discouraging in that voluntary feed intake and animal performance were very considerably reduced in comparison with fresh sugar cane.

It has been postulated that these negative effects were associated with the production of alcohol and, to some extent acetic acid, and that the former, at least, could be avoided by adding a solution containing ammonia to the sugar cane at the time of ensiling (Preston et al 1976).

The objective of the experiment described here was to examine the effect of different concentrations of both ammonia and on the ensiling of sugar cane, under laboratory conditions.

Table 1: Composition off additives (%)

	Ammonia/molasses	Urea/molasses
Final molasses, (80° Brix)	66.7	66.7
Aqueous ammonia [1]	33.3	
Urea		16.7
Water		16.6

[1]Contains 28.3% NH_3

Materials and Methods

Treatments and design:

The principal treatments were urea and ammonia each given at 5 different levels according to a 2 x 5 factorial design with one replication. The two additives were included at levels equivalent to 0, 1.6, 3.1, 4.7 and 6.2 g N per kg of chopped sugar cane stalk (fresh basis).

Glass jars of 4 litres capacity with a sealed top were used as experimental silos. Mature sugar cane stalk (Brix 17.5) was chopped finely in a high speed chopper and mixed with 0, 2, 4, 6 and 8% (weight/weight) of each of the solution, the compositions of which are given in table 1. Six different jars were prepared for each treatment combination, the objective being to open these on days 0, 2, 5, 10, 20 and 40. The experiment was started on 3 January 1975.

Table 2:
Organic acids (% inDM) in sugarcane ensiled with ammonia/molasses on urea/molasses

Amount of solution added[1]	Lactic acid		Acetic acid		Butyric acid	
	NH_3[1]	Urea[1]	NH_3	Urea	NH_3	Urea
0	4.67	4.67	1.5	1.5	-	-
2	12.50	4.80	1.3	1.6	-	1.3
4	7.53	4.80	.87	1.7	-	-
6	6.23	8,83	.63	1.8	.89	-
8	5.97	9.63	.60	1.6	1.	-

[1] Contains 7.85% N as NH_3 or urea

Measurements:

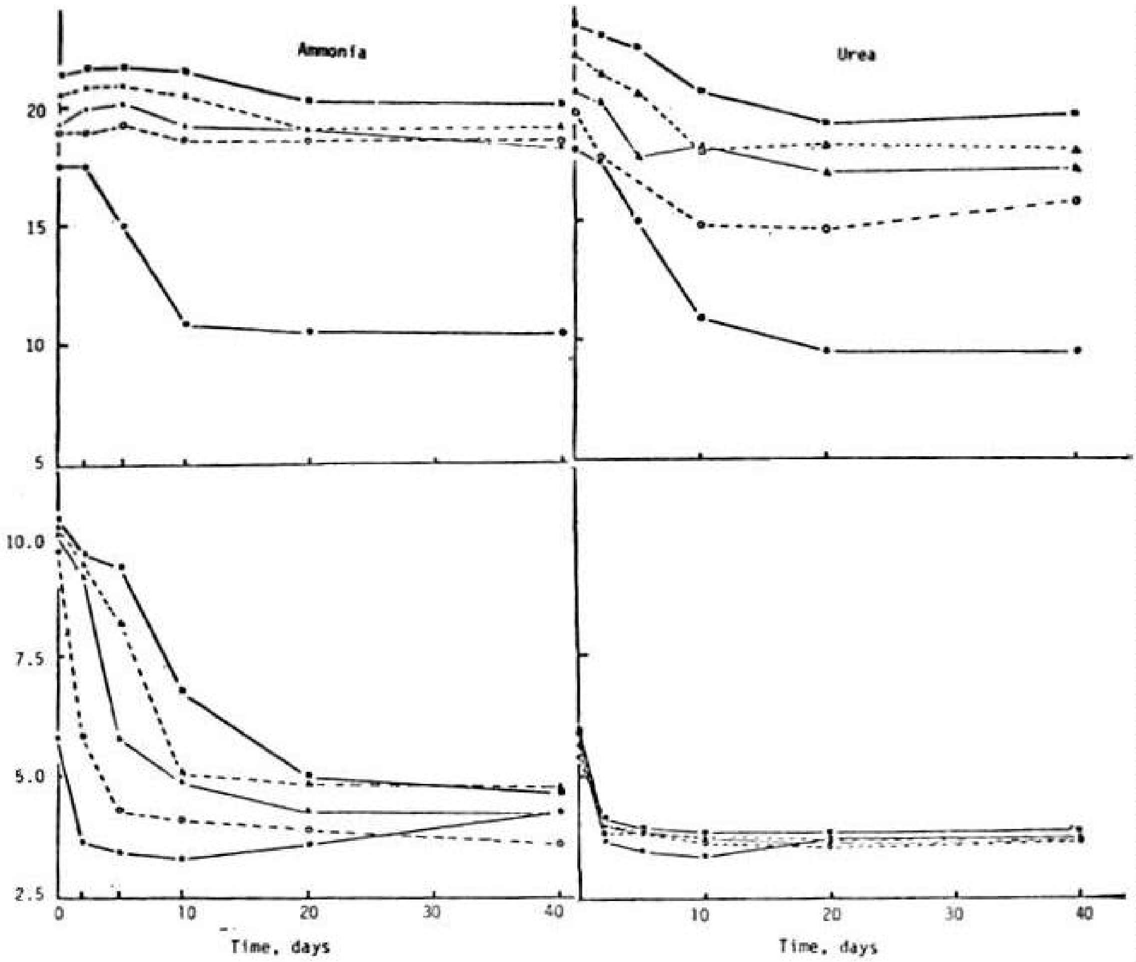
Samples were taken of the freshly prepared mixtures and from the silos when these were opened. They were mixed thoroughly after discarding the top 100 mm, and juice extracted with a hand press. Brix and pH were determined immediately on fresh juice. Other samples were preserved for subsequent analysis for lactic acid and volatile fatty acids by gas chromatography The methods were those described by González and MacLeod (1976)

Results and Discussion

The fermentation pattern, in terms of Brix and pH, during the process is set out in figure 1. Figure 2 shows the effect of the additives on the relative loss of sugars (Brix) while table 1 gives values for lactic, acetic and butyric acids.

The relationship between lactic acid and amounts added of urea and ammonia is presented in figure 2.

Figure 1:
Fermentation pattern in chopped cane stalk ensiled with a solution of molasses/ ammonia (66 kg molasses, 34 kg aqueous ammonia (28% NH_3) or molasses/urea (66 kg molasses, 17 kg urea, 17 kg water) concentrations of 0 (•), 20 (○), 40 (▲), 60 (△) and 80 (■) ml/kg of cane



There were very obvious differences between ammonia and urea in terms of their effects on the fermentation patterns. All levels of ammonia equally effective in preventing the reduction in Brix value observed with untreated cane. In contrast, the beneficial effect of urea appears to improve with increasing concentration.

Ammonia had a much more marked effect on the pH pattern. All the levels used raised the initial pH to about 10, while during the first 20 days of ensiling pH decreased according to the concentration of ammonia. Final values reached were, on the whole, similar to those recorded for the untreated cane. In contrast, urea had only a slight tendency to modify the pH pattern. The superiority of ammonia over urea in terms of preserving the original sugars in the cane , is very apparent from figure 2.

Figure 2:
Loss of sugars (Brix) in juice from sugar cane ensiled with solutions of molasses/ ammonia (•) or molasses/urea (◦)

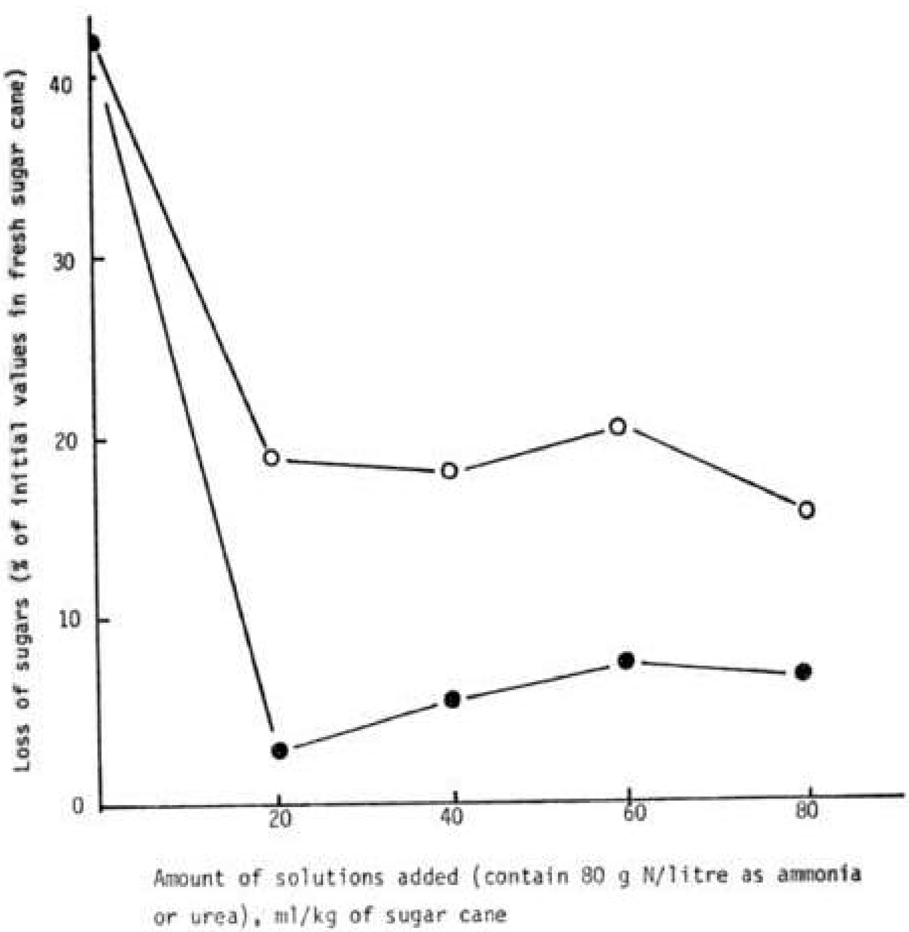
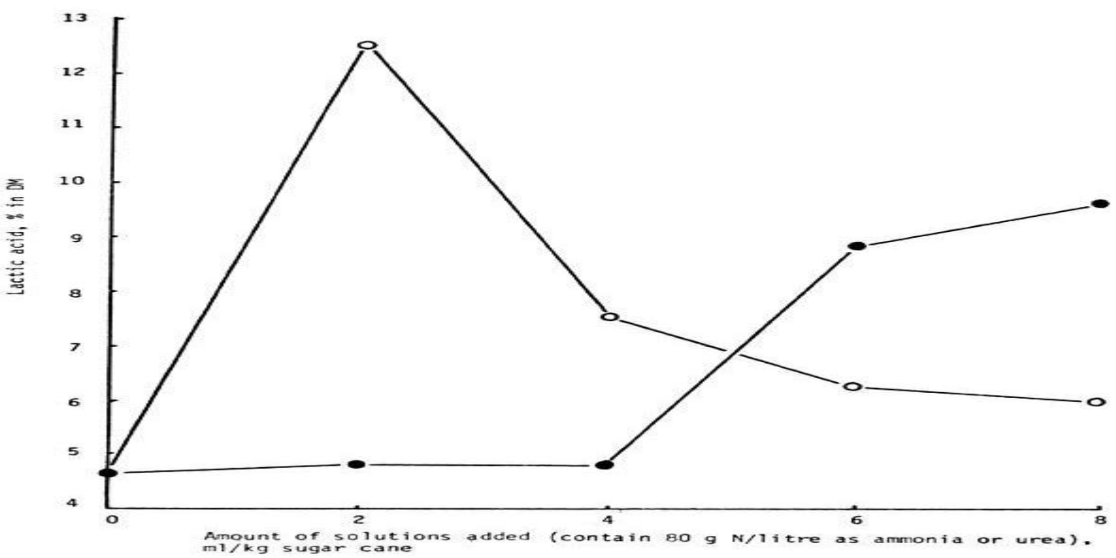


Figure 3:
Effect on lactic acid concentration in ensiled sugar cane of varying levels of ammonia (◦) or urea(•)



The data on contents of organic acids suggest that the use of both ammonia and urea gave rise to increases in lactic acid concentrations and a reduction in acetic acid. However. in the case of ammonia the optimum concentration appears to be the lowest one used (equivalent to 1.6 g added N per kg of silage), the values for lactic acid subsequently falling as more ammonia was added. The contrary was observed with urea, ie lactic acid increased with amount of urea added. The content of acetic acid decreased linearly according to the amount of ammonia added (r = -.97) hut there was a tendency towards an increase with urea level (r = .55). Butyric acid was only found in three of the samples and appeared to be unrelated to treatment.

In general terms, all the treated silages had an acceptable texture and smell; while the untreated silage was obviously inferior.

Conclusions

It would appear that the ensiling of sugar cane presents specific problems, not normally encountered with other forages. These appear to be related to its high content of soluble sugars and the fact that the conversion of these into alcohol and , to lesser extent, acetic acid, proceeds normally under anaerobic conditions due to fermentation by yeast. In most cases it will be necessary to include some form of additive to control this process, if maximum feeding value is to be retained in the ensiled material.

In this respect, ammonia appears to be more effective than urea Moreover, on world markets the unit price of nitrogen in ammonia is only half that in urea so there are therefore economical advantages from use of the former. The disadvantage is that ammonia is obnoxious to handle and ways must be found therefore to stabilize it as much as possible, if it is to be used under commercial conditions.

Dissolving ammonia gas in molasses, as proposed by Michigan workers (Henderson & Geasler 1970), is effective in general terms, but the fact that solubility of the ammonia in this mixture decreases with increase in ambient temperature, makes the process a little less suitable for use under tropical conditions (Preston et al 1976).

It also seems that the optimum levels of ammonia for use with sugar cane might well be lower than that found to be most effective with whole crop maize (Henderson and Geasler 1970).

Acknowledgements

We are grateful to Dr. T.H. Blackburn, for carrying out the analyses of the organic acids.

References

Henderson H & Geasler W 1970 Ammonia and mineral additions to corn silage J Anim Sci 31:243

James L A 1973 Comfith in rations for livestock feed Proc CIDA seminar on sugar cane as livestock Barbados 30-31 January 1973

Preston T R, Hinojosa C P & Martinez L 1976 Use of ammonia, molasses and mineral acids in the ensiling of sugar cane Trop Anim Prod 1:

Received 15 January 1976