ENSILING MIXTURES OF SUGAR CANE, CASSAVA FORAGE AND UREA[1]

G Ravelo, N A MacLeod[2] and T R Preston[3]

Centro Dominicano de Investigación Pecuaria con Caña de Azúcar
CEAGANA, S D

Laboratory scale silos (plastic sacks of 30 kg capacity) were used to evaluate the addition of cassava forage and urea in the ensiling of sugar cane. The treatments in a 2 x 6 factorial design with two replications were cassava forage at 0, 10, 15, 20, 30 and 45% (fresh basis) replacing sugar cane (122 Brix; 28% DM) and the absence or presence of urea (3% of the DM of the sugar cane). The cassava forage was the aerial part from 4 months old plants and contained 15% crude protein in DM, the DM content was 25%. Both forages were chopped to a particle size of between 10 and 20 mm and were ensiled for 20 days. Loss of sugars (Brix) was greatest on the control treatment while the degree of loss was less marked on the treatments with cassava and urea. The effect of these two additives on final pH showed a significant interaction; cassava forage caused increases in pH in the absence of urea and decreases in pH in the presence of urea. There was also an interaction with respect to lactic acid content which increased linearly with level of cassava in the presence of urea to a maximum concentration of 4.2%in DM with 45% cassava; while in the absence of urea the overall value was significantly lower and related curvinearly with level of cassava.

Key words: Sugar cane, cassava forage, urea, ensiling

There are several reasons which justify the ensiling of sugar cane. In the wet season, harvesting presents many difficulties from the point of view of management and transport. Further more the maximum nutritive value of the sugar cane for animal feeding coincides with the dry season (Alvarez and Preston 1976a).

Studies have been carried out on the use of additives such as aqueous ammonia, urea, final molasses and calcium phosphate as a means to improve the nutritive value of the ensiled product (Alvarez and Preston 1976b; Lopez and Preston 1976). The best seems to be aqueous ammonia which acts as a buffering agent as well as a source of nitrogen. By helping to maintain higher pH values in the early phase of the ensiling process, development of facto-bacilli is encouraged replacing yeasts which

---

[1] This work was supported in paint by funds provided by the Organization of American States through the project Fondo Mar del Plata

[2] On secondment from Rowett Research Institute Aberdeen, Scotland

[3] Scientific Adviser to CEAGANA through the FAO/UNDP project DOM/71/506

are undesirable since they ferment sugars to alcohol.

The use of cassava forage as a potential protein source in sugar cane and molasses based diets is a recent innovation (Moore.1976; Meyreles et al 1977a), and has been based on harvesting and feeding the fresh forage on a daily basis. It is probable that. there would also be management advantages if the harvesting of cassava could be concentrated in a short period. This approach would obviously require some method for conserving the cassava forage after harvesting.

The objective of this experiment was to study the characteristics of different mixtures of sugar cane and cassava forage with and without urea, in order to evaluate the possibility of preparing a complete ensiled diet.

Materials and Methods

Treatments and Design: The treatments in a 6 x 2 factorial design with 2 repetitions were levels of cassava forage of 0, 10, 15, 20, 30 and 45% (fresh basis), and of 0 and 3% urea in the dry matter of the sugar cane. The different mixtures were ensiled over a 20 day period in plastic bags with capacity of 30 kg. The cassava forage was the aerial part of the plant which had been established at a high population density (approximately 50,000 plants per ha) and which had been cut at approximately 4 months of age at a level of 30 cm above the ground. The cassava forage contained 24% of dry matter and 15% of protein in the dry matter. Whole sugar cane was used containing 28% of dry matter and 12° Brix in the juice. Both the sugar cane and the cassava forage were chopped in a Gehl forage chopper to a particle size of 10 to 20 mm. For the urea treatment an aqueous solution of urea in water (equal parts by weight) was prepared and mixed intimately with the sugar cane and cassava. The sacks were filled and compressed by hand with the aim of excluding as much air as possible They were then sealed and kept at ambient temperature in the shade during the 20 day ensiling period. Samples were taken of the material before sealing the sacks and 20 days later when they were opened.

Measurements: Determinations were made of dry matter and of nitrogen in the complete material and of Brix, pH and lactic acid in the juice.

Results and Discussion

Mean values for the different parameters measured in this experiment are given in table 1. The addition of urea led to significantly higher values for pH both before and after ensiling (table 2).

Table 1:

Mean values for fermentation parameters

	Level of cassava forage, %					
	0	10	15	20	30	45
pH						
Initial						
No urea	4.8	5.0	5.2	5.0	5.2	5.1
With urea	5.2	5.5	5.3	5.3	5.1	5.3.
Final						
No urea	3.3	3.5	3.6	3.4	3.7	3.7
With urea	4.8	4.3	4.6	4.2	4.0	4.4
Brix values						
Initial						
No urea	13.	12.1	11.5	12.0	12.5	11.0
With urea	12.8	12.3	12.5	12.2	11.8	11.7
Final						
No urea	6.5	9.4	8.5	9.5	7.0	8.0
With urea	8.5	10.0	8.0	9.5	8.5	8.75
Dry matter, %						
No urea	27.5	26.5	26.3	29.0	24.5	27.0
With urea	26.5	28.0	28.0	26.0	25.0	26.0
Nitrogen, % in DM						
No urea	.42	.56	.74	.73	.85	.86
With urea	2.08	1.54	1.71	1.87	2.05	1.66
Lactic acid, % in DM						
No urea	.80	1.20	1.65	1.75	1.25	1.50
With urea	1.20	1.70	2.50	2.80	2.70	4.20

There was a significant interaction between the effect of cassava and urea on pH with cassava having the effect of reducing pH after ensiling in the presence of urea and of increasing it both before and after ensiling in the absence of urea (:see figure 1). In all cases the final pH values were satisfactory in terms of adequate preservation of the ensiled material.

Figure 1:
Effect on pH of ensiling sugar cane with cassava forage and urea

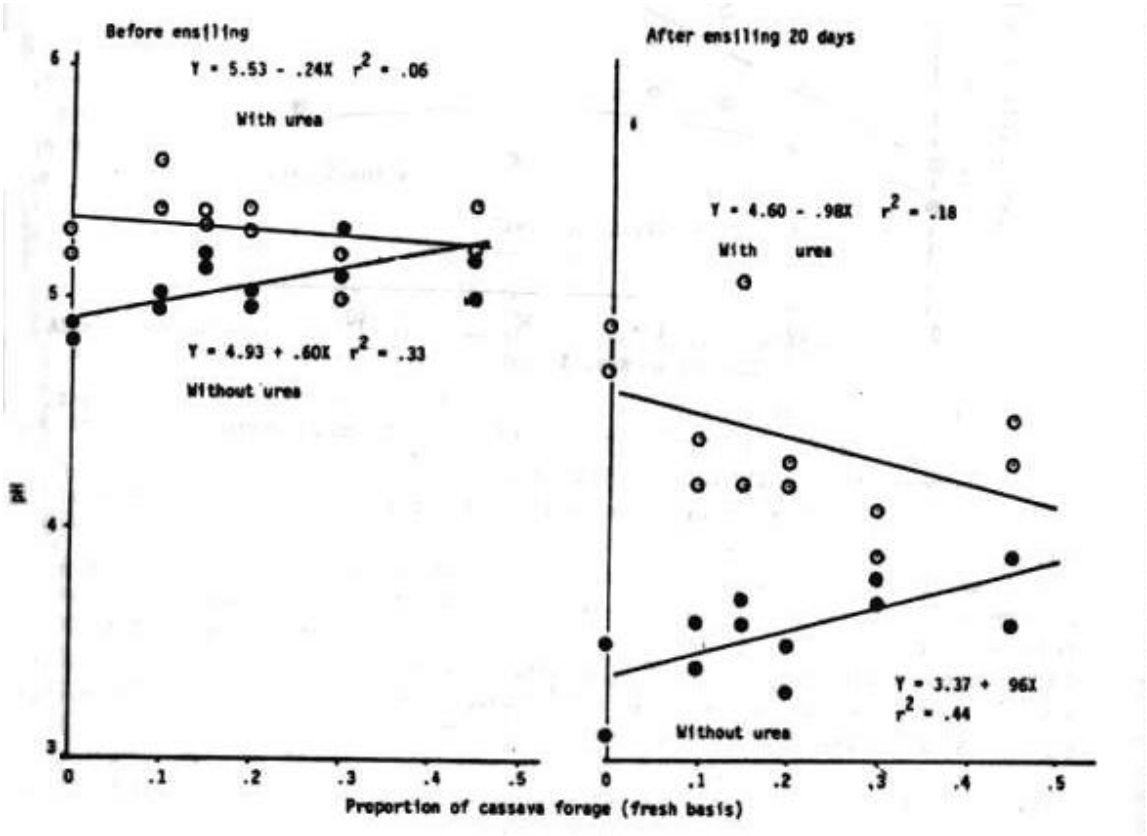
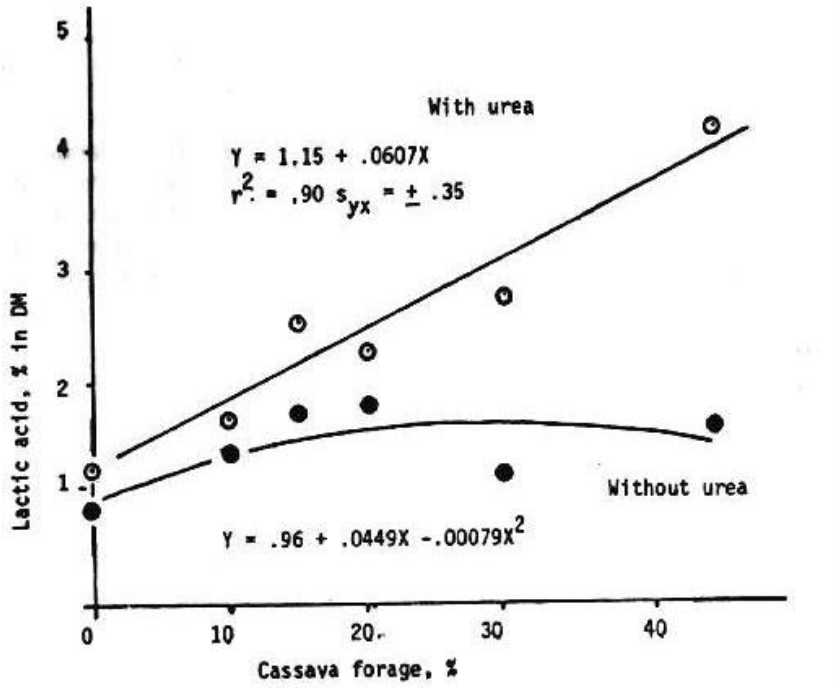


Table 2:
analysis of variance for pH

	before ensiling				After ensiling			
	Degrees freedom	Mean square	F value	Probability	Degrees freedom	Mean square	F value	Probability
Item								
Cassava	5	. 028	3.05	.05	5	.07	1. 22	.35
Urea	1	.375	4.09	.001	1	4.25	76.7	.001
Cassava x urea	5	.052	5.67	.006	5	.17	3.06	.05
Residual	12	.0092			12	.0554		

Figure 2:
Lactic acid in sugar cane ensiled with different amounts of cassava forage and urea



The effect of urea and cassava on Brix values was less obvious but calculating the loss in Brix (initial - final value /initial value) as an indicator of excessive fermentation of the sugars, then in the absence of urea this loss was reduced by inclusion of cassava forage (P <.04) while there were no significant effects of the cassava forage in the presence of the urea. The overall effect of urea was to give higher final values of Brix (P <.11; according to a paired "t" statistical analysis).

The other important observation was the effect of treatment on lactic acid concentration (figure 2). In the presence of urea, increasing levels of cassava forage gave rise to a linear increase in lactic acid concentration to reach a maximum value of 4.2% in DM. with 45% cassava forage. In the absence of urea the response was curvilinear, overall values being significantly lower (P <.001 by the "t" test) than in the presence of urea, and with the maximum value of 1.8% lactic acid in DM at 20% level of cassava forage.

All of the silages containing cassava forage had an excellent appearance and smell, and were considered to be superior to previous samples of ensiled sugar cane (Ravelo et al 1974; Silvestre et al 1976).

The effect of urea in maintaining higher pH values during the ensiling process, and reducing the degree of fermentation of sugars, is in agreement with the earlier report of Alvarez and Preston (1976b) The benefit from including the cassava forage was unexpected, but is in line with observations concerning the apparent high solubility of the cassava protein. The effect of the cassava in increasing pH and lactic acid

concentration, could be explained by its buffering action, which would result from the hydrolysis of the protein to peptides and amino acids during the ensiling process. These may also have contributed directly to the growth of lactobacilli. Evidence for high solubility of cassava protein was put forward by Meyreles et al (1977b) and Ravelo et al (1977), on the basis of high rumen ammonia production when cassava forage was fed in combination with sugar cane.

Conclusions

It would appear that inclusion of cassava forage and urea in ensiled sugar cane improves the end product in terms of lactic acid concentration and a higher degree of conservation of the original sugars in the cane The value of the nitrogen fraction in the ensiled mixture in terms of animal performance is not known.

References

Alvarez P J & Preston T R 1976b Ammonia/molasses and urea/molasses as additives for ensiled sugar cane Trop AnIm Prod 1:98-104

Alvarez F J & Preston T R 1976a Performance of fattening cattle on immature or mature sugar cane Trop Anim Prod 1:106-111

Lopez J M & Preston T R 1976 The use of buffers containing rock phosphate, ammonium sulphate and ammonium hydroxide in the ensiling of chopped sugar cane Trop Anim Prod 1:33al

Meyreles L, MacLeod N A & Preston T R 1977a Cassava forage as a source of forage protein: effect of population density and age at cutting Trop Anim Prod 2:18-26

Meyreles L, MacLeod N A & Preston T R 1977b Cassava forage as a protein supplement in sugar cane diets for cattle; effect of different levels on growth and rumen fermentation Trop Anim Prod 2:

Moore C P 1976 El uso de forraje de ynca en la alimentacidn de rumiantes, Seminario Internacional de Ganaderia Tropical, Acapulco, Mexico

Ravelo G & Preston T R 1974 Ensilaje de Caña de Azúcar con diferentes niveles de melaza con y sin amonIaco e in6eolo de melaza prefermentada con estidrcol Informe Anual, CIEG, Chetumal, Mexico

Ravelo G, MacLeod, N A & Preston T R 1977 Rumen ammonia production as affected by partial drying of cassava forage given in combination with sugar cane Trop Anim Prod 2: abs

Silvestre R, MacLeod N a & Preston T R 1976 Sugar cane ensiled with urea or ammonia for fattening cattle Trop Anim Prod 1:216-222

Received 20 December 1976