CASSAVA OR SWEET POTATO FORAGE AS COMBINED SOURCES OF PROTEIN AND ROUGHAGE IN MOLASSES BASED DIETS: EFFECT OF SUPPLEMENTATION WITH SOYBEAN MEAL[1]

D Ffoulkes and T R Preston[2]

CEDIPCA, CEAGANA, Apartado 1256, Santo Domingo, Dominican Republic

Sixteen bulls of 216 kg initial weight were used to compare forage from cassava (4% of liveweight) or sweet potato (5% of liveweight) with and without supplementation of 400 g/d of soybean meal in a 2 x 2 factorial design with 2 replications using a basal diet of molasses containing 2.5% urea fed on a free choice basis.

Rate of liveweight gain on sweet potato forage was increased significantly by the addition of soybean meal (from 570 to 784 g/d); on cassava forage there was a tendency for the same effect but the difference was not significant (from 853 to 944 g/d). The effects of the forages (and soybean supplement) appeared to be mediated through effects on voluntary intake' which in turn was closely related to liveweight gain (r^2=.75 for gain and DM intake, and r^2= .69 for gain and protein intake).

There was a significant interaction between the effects of the different forages and the level of soybean meal on the feed conversion ratio. In the absence of soybean meal. cassava forage was better than sweet potato; but in the presence of soybean meal (ie when protein was not limiting) the opposite effect was observed.

The importance of the results of this experiment relate to the general development of cattle feeding systems based on the use of high levels of molasses/urea, in that they offer the perspective for achieving high levels of animal performance without the need to use conventional protein supplements which have become increasingly scarce and expensive during the last few years.

Key Words: Cattle, molasses, urea, sweet potato forage, cassava forage, fattening

The work of Fernandez et al (1977) and Fernandez and Preston (1978) has shown that it is possible to obtain good growth rates in fattening Zebu cattle using cassava forage as the only source of protein and fibre in a molasses based diet. As cassava is a traditional crop grown on farms in the Dominican Republic, it offers an attractive alternative to supplementing fattening diets with imported concentrates.

Another locally grown crop is the sweet potato, *Ipomoea batatas*. Forage from this plant has a similar protein content to cassava forage. It was therefore appropriate to evaluate sweet potato forage as an alternative to cassava forage in molasses based fattening diets.

Materials and Methods

Treatments, Animals and Design: Two forage types, cassava and sweet potato, were compared with and without supplementation of 400 g/d of soybean meal in a 2 x 2 factorial design with two replications. Twelve Zebu and four Holstein x Zebu bulls were allocated according to liveweight to give the two replicates of two animals per treatment. The average initial weight was 216 kg and the duration of the experiment was 130 days.

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[2] FAO Consultant to the Project DOM/77/002

Diet: The forage from cassava (variety Zenon) and sweet potato (mixed local varieties) was taken from 4-5 month-old stands which had received approximately 100 kg DM of digested cattle manure/ha/3 days. Cassava forage was the aerial part of the plant cut 30 cm above ground level, while sweet potato forage consisted of everything that could be raked together after cutting the stem at ground level. In neither case were the roots harvested but rather used as reserve material to stimulate rapid forage regrowth.

The forages were chopped separately in a Hesston 2000 maize forage harvester and given immediately as a single feed at a level of 4% (fresh weight) of animal liveweight for the cassava, and 5% for sweet potato. A solution of molasses containing 2.5% urea (w/w) was provided on a free choice basis in a separate feeder and all animals received 60 g/d of mineral supplement (50 dicalcium phosphate/50 common salt).

Measurements: The animals were weighed every 14 days. Dry matter (DM) determinations of the forages were from a number of samples taken at weekly intervals throughout the trial.

Table 1:
Mean values for liveweight change, feed intake and feed conversion for Zebu and crossbred bulls fattened on ad libitum molasses/urea and restricted amounts of cassava or sweet potato forage, with or without soybean meal (127 days; 4 bulls per treatment)

Soybean meal g/d	0		400		SEx (P) [1]
Forage type	Cassava	Sweet potato	Cassava	Sweet potato	
Liveweight, kg					
Initial	204	217	227	218	± 8.1 (.62)
Final	317	287	349	316	± 15.0 (.08)
Daily gain [2]	0.853	0.570	0.94	40.784	± 0.08 (.02)
Fresh feed intake, kg/d					
Forage	8.68	10.58	9.24	11.16	-
Molasses	4.54	4.75	5.82	4.83	-
Soybean meal	-	-	0.40	0.40	-
DM intake, kg/d					
Forage	2.19	1.45	2.32	1.51	-
Total	5.36	4.72	6.79	5.28	± 0.35 (.12)
Voluntary Consumption Index[3]	2.06	1.87	2.36	1.98	± 0.13 (.30)
Conversion[4]	6.28	8.28	7.19	6.74	± 0.42 (.13)

[1] (Probability of "F" test)

[2] Calculated from regression analysis of individual weights vs time

[3] Daily DM intake per 100 kg LW

[4] DM intake/gain in LW

Statistical Analyses: Initial and final weights were analysed using individual values of two animals per pen. Rates of liveweight gain were calculated by the linear regression of individual weights against time. Analyses of DM feed intakes and feed conversion ratios were based on the mean values for pens.

Results

Mean values for liveweight change, feed intake and feed conversion are presented for each combination in Table 1 and for the main treatment effects in Table 2. Figure 1 illustrates the growth curves of each combination during the trial. The analyses of variance show significant differences in daily liveweight gain during the experiment as between individual treatment combinations. Most of this effect was due to the difference between the two forages (P <.01) with cassava being superior (0.90) to sweet potato (0.68 kg/d). There was also a significant effect of supplementation with soybean meal (P< .05) but the differences here were less striking (0.71 vs 0.86 for without and with soybean meal respectively).

Table 2: Effect of forage type and of soybean meat on weight gain, feed intake and conversion of bulls given a molasses based diet: mean values for main treatment effects

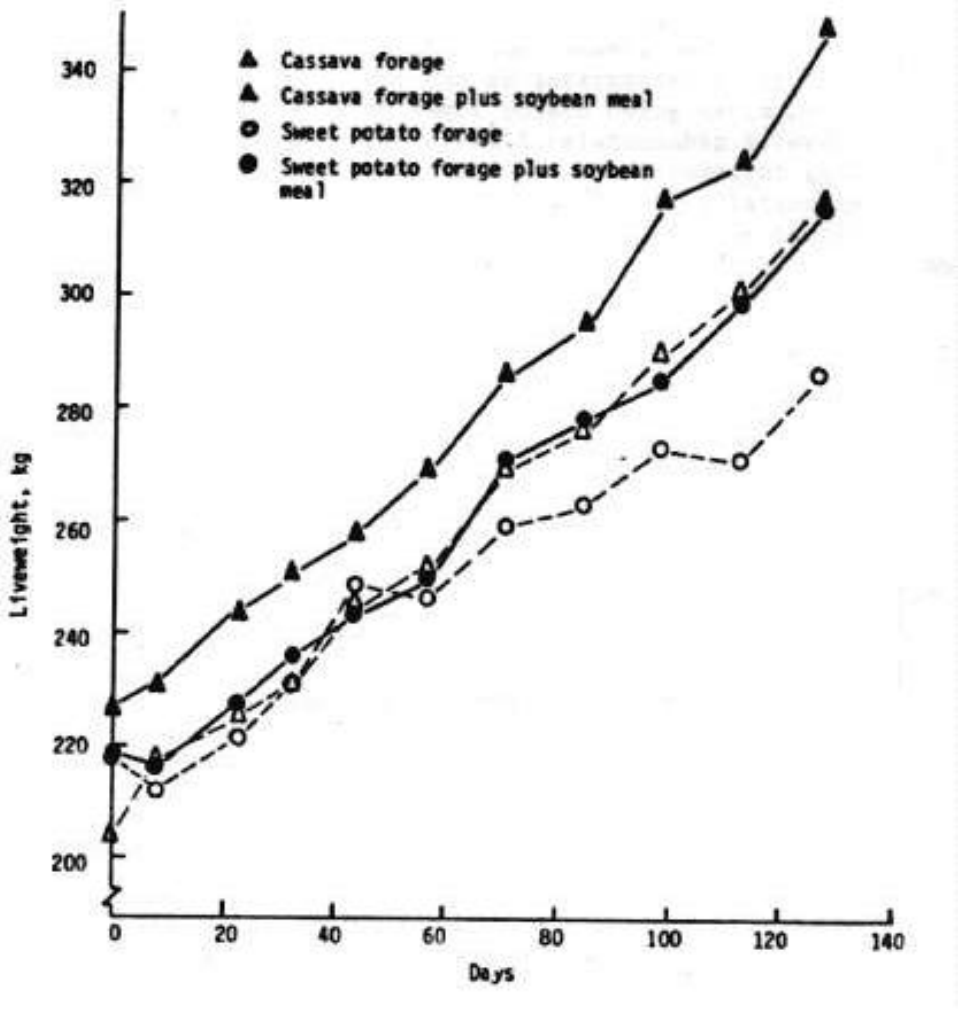
	Effect of forage type		P[1]	Effect of soybean meal		P[1]	SEx
	Cassava	Sweet potato		0 g/d	400 g/d		
Daily gain[2] , kg	0.90	0.68	0.01	0.71	0.86	0.06	0.05
Intake, kg DM/d							
Forage	2.26	1.48	-	1.82	1.92	-	-
Molasses/urea	3.63	3.35	0.14	3.25	3.73	0.05	0.13
Soybean meal	0.17	0.17	-	-	0.35	-	-
Total[3]	6.08	5.00	0.03	5.04	6.04	0.04	0.25
Conversion[4]	6.61	7.55	0.07	7.32	6.84	0.22	0.30

[1] Probability of "F" test
[2] Calculated by regression of individual values
[3] Excluding 60 g minerals/d
[4] DM intake/unit gain

Treatment effects on DM intake were similar to those observed on liveweight gain, in fact there was a close relationship between these two parameters (r^2 = .75) (see Figure 2).

The analysis of variance of feed conversion ratio (Table 3) showed a significant interaction (P< .08) between the effects of the different forages and of the level of soybean. In the absence of soybean meal, cassava forage was better than sweet potato; but in the presence of soybean meal the opposite effect was observed.

Figure 1:
Growth curves of zebu and crossbred bulls on a molasses based diet and different sources of forage in the presence and absence of soybean meal



Discussion

The growth curves in Figure 1 suggest that there was a short period of adaptation on the diet with sweet potato forage. The animals had already been receiving molasses prior to starting the experiment, and also there was no apparent set-back on the treatment with cassava forage. Thus the slight set-back is unlikely to have been due to the molasses (see Fernandez and Preston 1978).

Throughout the experiment there was an average feed refusal of 13 ± 1.4% and 10 ± .8% (x ± SE) for cassava and sweet potato forage respectively (in terms of the original amount offered). The true consumption level of forage (fresh weight basis) expressed as a percentage of body weight was therefore closer to 3% for cassava and 4% for sweet potato.

Figure 2:
Relation between daily dry matter intake (X) and rate of liveweight gain (Y) for bulls fed ad libitum molasses/urea and cassava or sweet potato forage with or without soybean meal

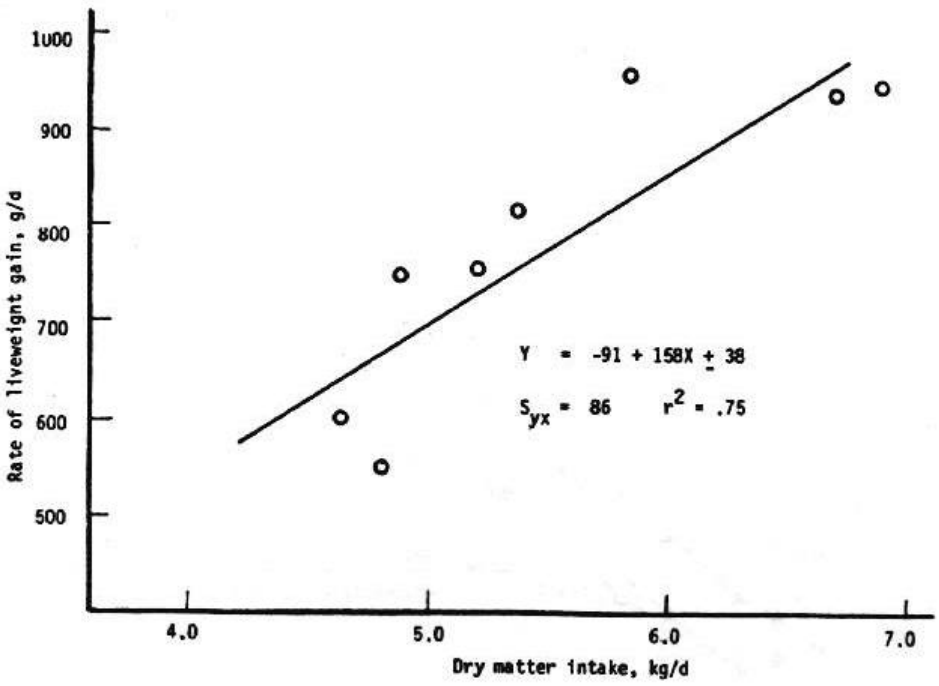


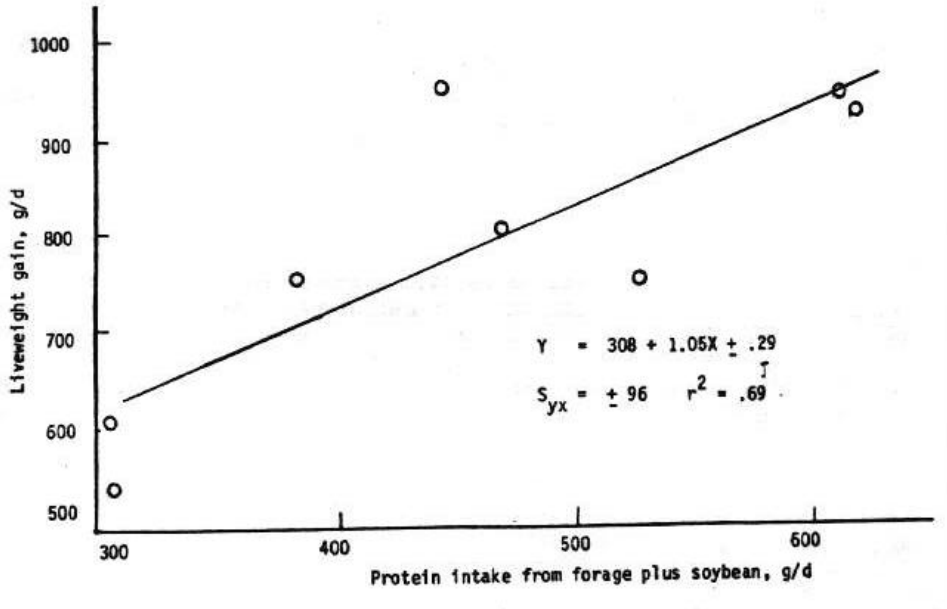
Table 3 :
Analysis of variance for feed conversion in Zebu bulls fed molasses/urea supplemented with sweet potato or cassava forage

Sources of variation	Degrees of freedom	Mean square	F	Probability
Replicates	1	0.01	-	-
Treatments	3	1.52	4.3	.13
Forage	1	1.77	1.42	.32
Soybean	1	0.47	1.33	.33
Forage x Soybean	1	2.31	6.54	.08
Residual	3	0.353	-	-

The reason for these refusals is not evident as previous authors have had no difficulty in feeding higher levels.

The general findings of this experiment add support to the hypothesis that on molasses/urea diets the principal limiting factor to animal performance is by-pass protein. The slight improvement due to giving soybean meal on the cassava diet and the significant improvement caused by the protein supplement on the sweet potato diet can be interpreted as protein effects, the greater effect of soybean with sweet potato being explained by the lower protein intake on this forage. The overall relationship between true protein (provided by the forage and soybean meal) and the liveweight gain of the animals is shown in Figure 3. Some 70% of the total variation in animal performance could be explained by the amount of total true protein in the diet.

Figure 3:
Relationship between protein intake (X) and rate of liveweight gain (Y) for bulls fed ad libitum molasses/urea and either cassava or sweet potato forage with or without soybean meal



The significant interaction on feed conversion ratio due to opposing effects of forage and supplementary soybean protein, also supports the hypothesis that protein was the principal limiting nutrient. Sweet potato forage is more digestible that cassava forage (Ffoulkes et al 1978a,b), and therefore it would be expected that other things being equal, a better feed conversion (DM basis) should be obtained with sweet potato than with cassava in molasses based feeding systems. The data indicate that this was so when protein was not limiting (ie in the presence of soybean meal), but that when protein was limiting this had the primary effect on feed conversion ratio.

It is interesting to compare the relatively high levels of total protein (600 g/d) required in order to achieve maximum performance on these supplements, with the amounts required when fish meal has been used (Preston 1972); in the latter case maximum performance was achieved with approximately 480 g/d of protein (360 from the fish meal and 120 from the roughage), This indicates that probably a greater proportion of the forage protein is degraded as compared with that from fish meal. This would be expected on the basis of analytical data. For example, Kempton et al (1977) reported that 65 to 100% of the protein in fresh ryegrass was fermented in the rumen, compared with 20 to 80% for fish meal.

If this is the case then there would be a strong argument for attempting to treat the forages of sweet potato and cassava with substances such as formaldehyde in order to reduce the rate of protein digestibility and hopefully permit the same level of animal performance to be achieved with smaller amounts of forage.

Conclusions

The importance of the results of this experiment relate to the general development of cattle feeding systems based on the use of high levels of molasses/urea, in that they offer the perspective for achieving high levels of animal performance without the need to use conventional protein supplements, which have become increasingly scarce and expensive during the last few years.

It is believed that the slightly poorer results on the sweet potato forage supplement, simply reflected inadequate levels of consumption of this material. Another trial which is now in progress, where levels of sweet potato forage have been raised to 8%, is providing evidence that at this level of supplementation the level of animal performance will be the same as that achieved with cassava forage in the present trial.

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