NUTRITIVE VALUE OF SWEET POTATO FORAGE (*IPOMOEA BATATAS* (*L.*) *LAM.*) AS A RUMINANT ANIMAL FEED

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ABSTRACT

*Four varieties of sweet potato (*Ipomoea batatas*) (L.)* Lam.*) were tested for their forage production and nutritive value as a ruminant feed in subtropical Queensland. Forage was harvested 63, 104, 159 and 199 days after planting and assessed for yield and nutrient composition. Forage yields varied with age and variety. Red Abundance was the most productive variety, yielding 22 t dry matter (DM) per ha at 199 days. The DM contents of all varieties were initially low (79 to 119 g/kg) and increased (to 132 to 183 g/kg) with age, whereas the protein contents decreased with age from 146 to 103 g/kg DM. Neutral detergent fibre contents varied little from a mean of 467 g/kg DM, both between varieties or over the growing period. The mean DM digestibility coefficient of material obtained at 199 d was 0.76 and varied little between varieties. These forage production and nutrient content data suggest that sweet potato may provide a useful source of forage for ruminants.*

Key words: Sweet potato forage, nutritive value, ruminants.

INTRODUCTION

World production of sweet potato roots is some 130 million tonnes, obtained from approximately 9 million ha (FAO 1989). The crop is grown principally for its roots, but large amounts of vines and leaves are produced and these are usually left unutilised in the field. Some varieties can be sown 2 to 3 times each year, with annual yields of up to 125 t of fresh biomass of which forage accounts for approximately 64% (Pinchinat 1970). The total forage (vines plus leaves) contains 110 to 170 g/kg crude protein, and its digestibility is greater than 0.60 (Ffoulkes *et al.* 1978, Ruiz *et al.* 1980).

These data suggest that sweet potato could potentially be a useful ruminant feed in addition to its accepted use as a human foodstuff. The experiment reported here was designed to provide some information on the production and quality of sweet potato forage produced in a Queensland environment. This study examined the yield, digestibility and chemical composition of the forage from 4 varieties which are either currently grown in Queensland, or which have potential as root crops.

MATERIAL AND METHODS

Four varieties were tested, of which L0323, Rojo Blanco and NC3 were early-maturing and Red Abundance was a late-maturing variety. The performance of these varieties was assessed at each of 4 harvesting times, 63, 104, 159 and 199 d after planting on 11th December, 1990. The plants were grown in a field trial at The University of Queensland, Gatton College, Lawes (27° 33′ South, 150° 20′

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east, altitude 91 m) on a soil typical of the Black Earths of the Lawes soil series (Schafer *et al.* 1986). During the trial period from December 1990 to May 1991, 315 mm of rain was recorded at the Lawes meteorological station with 81% falling between December and February. The maximum temperatures were between 24 and 34°C and minimums between 9 and 20°C during this period.

A randomized complete block design was used, with 4 varieties and 4 harvesting times as treatment. Each block contained 16 plots each 3.4 m x 1 m. There were 4 plots for each variety for each harvesting time with 16 plants in each plot. Individual plants were planted 25 cm apart on ridges at 85 cm spacing. Adjacent plots were separated by 85 cm at the sides and 1 m at the ends.

Planting material consisted of 20 to 30 cm long cuttings with about 4 nodes, obtained from the apical portions of vines from mature plants. The cuttings were trimmed, leaving 1 or 2 young leaves, and then placed in 10 to 15 cm of water for 3 d to stimulate root growth before planting out in the field.

The crop was irrigated daily from the time of field planting to partial field establishment, a period of 3 weeks. Subsequently, irrigation was on a regular weekly basis. Regular hand weeding was carried out until the plants were well established, after which little weeding was required. No basal fertiliser was applied.

Forage (vines plus leaves) was sampled by harvesting the whole plot of 16 plants. The harvested material was chopped into approximately 5 to 10 cm lengths, weighed, mixed, and duplicate subsamples of 2 to 3 kg were dried at 60°C in a forced draught oven for 24 h for the estimation of DM content and DM presentation yield. The dried material was then bulked, ground through a 1 mm screen, mixed and sub-sampled for subsequent chemical analysis.

Analyses of the ground, air-dry forage were conducted for dry matter (ISO 1983), total ash (500°C for 4 h), total protein (by a semi-micro Kjeldahl technique using $CuSO_4$ catalyst), and neutral detergent fibre (NDF) as described by Goering and Van Soest 1970 and Moir 1971. Digestibility of the forage harvested at 199 d was determined by *in sacco* incubation using the procedure described by Dryden and Leng (1988). Samples of about 3 g of prepared air-dry sample (ground through a 1 mm screen and sieved to remove particles less than 0.45 mm) incubated in rumenfistulated wether sheep for 48 h. Each sample was incubated in each of 5 sheep, and between-run variation was accounted for by including a standard lucerne hay sample in each run.

Differences between means were examined by one-way analysis of variance, using the Minitab statistical package (Minitab 1989). Where significant differences were indicated, means were compared by the calculation of appropriate least significant differences.

RESULTS

The forage yield of all varieties increased linearly, both in DM (Fig. 1) and OM (Fig. 2) between 63 and 159 d, although different varieties grew at different rates. For each variety, DM yield at 199 d was not different from that at 159 d. Red Abundance was more prolific than the other varieties, yielding significantly more forage at 104, 159 and 199 d.

The DM content were low in the young forage (a pooled mean of 89 g/kg), but increased with age (Table 1). The DM content of each variety at the 199 d harvest was significantly higher than those of the earlier harvests. At 199 d, the earlier maturing varieties had significantly higher DM contents than Red Abundance. Organic matter contents increased with age, but there were no differences between varieties at the later harvests (Table 1). There was no effect of either variety or time on NDF contents, with individual values not differing significantly from

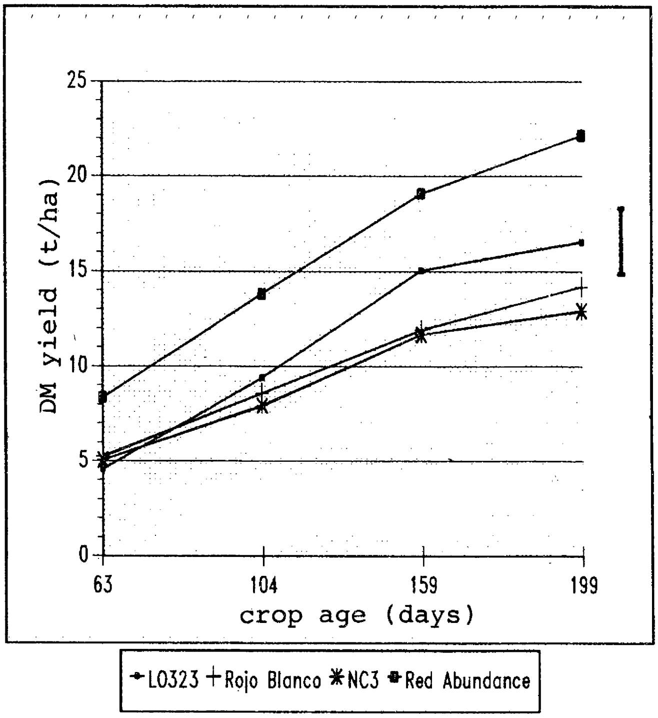

Figure 1. **Dry matter yields of sweet potatoe forage. Vertical bar, LSD p=0.05.**

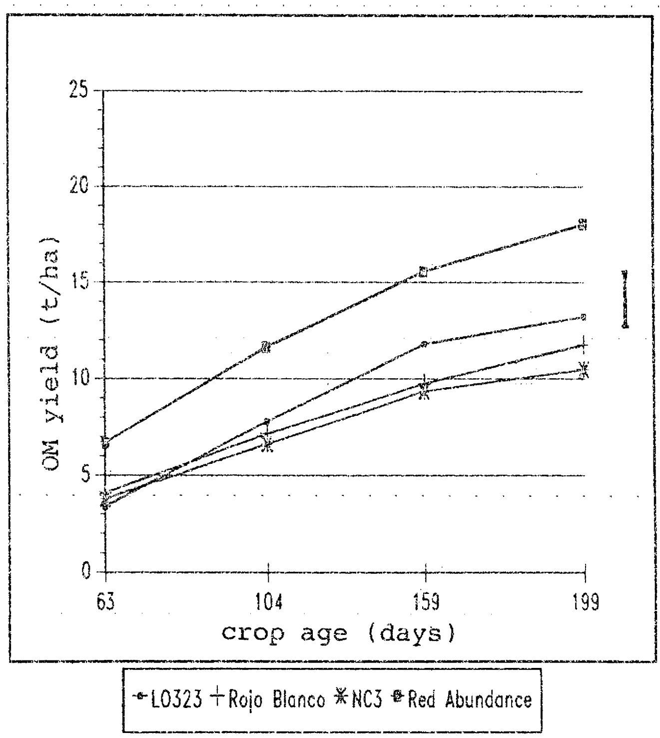

Figure 2. **Organic matter yield of sweet potatoe forage. Vertical bar, LSD p=0.05.**

the overall mean of 467 g/kg DM. Total protein varied from 77 to 151 g/kg DM over the 4 varieties and harvesting dates. Significantly lower protein contents were recorded in the final harvest than in the first harvest, except for Red Abundance (Fig. 3). There were no significant differences between varieties at the 63, 104 and 159 d harvests, but at the final harvest L0323 and Rojo Blanco had significantly less protein than Red Abundance.

The mean DM digestibility coefficient of the forage harvested at 199 d was 760 (SD, 41.4) g/kg. There was little variation between varieties.

DISCUSSION

The prevailing temperatures during the growing period were favourable for sweet potato growth, and a deficiency in rainfall was overcome by regular irrigation. Growing conditions were considered to allow the full expression of the production potential of these varieties.

Variations between sweet potato varieties have been reported by many researchers and the variation in forage production obtained in this experiment was expected. Red Abundance (the late-maturing variety) was the most productive variety, especially

Table 1. **Dry matter and organic matter contents of sweet potato forage.**

		Crop age (days)				
		63	104	159	199	mean
Dry matter	L0323	78.8	107.5	105.0	153.9	111.3^{b}
contents	Rojo Blanco	96.7	118.7	111.8	183.2	127.6^{b}
(g/kg)	NC3	82.5	116.7	114.0	162.7	118.9^{b}
	Red Abundance	99.7	114.0	98.2	132.1	111.0^{b}
	mean	89.4^{c}	114.2^{b}	107.3^{c}	158.0^{a}	
						mean
Organic matter	L0323	751.9	830.1	785.7	799.5	791.8^{c}
contents	Rojo Blanco	780.3	835.8	818.5	831.0	816.4^{a}
(g/kg)	NC3	749.7	835.6	800.9	812.4	799.7^{b}
	Red Abundance	799.5	843.3	812.4	814.4	817.4^{a}
	mean	770.4^{d}	836.2^{a}	804.4^{c}	814.3^{b}	

^{abcd} **mean with same superscript do not differ significantly (P<0.05).**

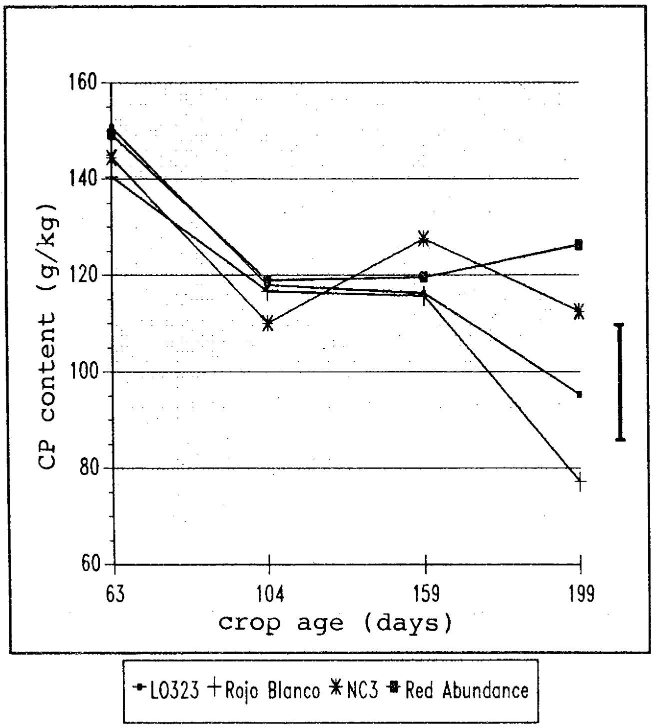

Figure 3. **Crude protein content of sweet potatoe forage. Verticle bar, LSD p=0.05.**

at the last 3 harvests, and at 199 d yielded 34, 56 and 72% more DM than that obtained from L0323, Rojo Blanco and NC3, respectively. The productivity of Red Abundance is illustrated by the observation that it yielded more at 63 d than Rojo and NC3 at 199 d, and as much at 104 d as L0323 at 199 d. Trends in organic matter yields were similar to those of DM. The forage yields obtained here were similar to those reported elsewhere (e.g. Huett 1976; Huett and O'Neil 1976; Rose 1979; Ruiz 1982; Villareal *et al.* 1982) over the same growth period. The data from this experiment indicate that a similar growth pattern occurred in all varieties, with a nearly linear increase in forage production from planting to about 159 d and a slower growth thereafter. The marketable root yield at 199 d was 106, 74, 93 and 68 t/ha for L0323, Rojo Blanco, NC3 and Red Abundance respectively. At 159 d, marketable root yield was 69, 55, 80 and 53 t/ha respectively and at this stage between 11.7 and 19.1 t of forage was produced. As there was no further significant increase in forage production after 159 d, there would be little advantage in delaying harvesting or grazing after that time.

The DM digestibilities suggest a metabolisable energy content of 10.5 MJ/kg DM at 199 d, estimated by the relationships given by MAFF (1984). It is suggested that this value may apply during the whole of the growth of the forage, as there was no significant change in total cell wall (NDF) content with age. The lack of variation in digestibility with crop age has been reported by Ruiz *et al.* (1980).

The protein contents determined in this study are in agreement with values reported elsewhere (NAS 1971; Gohl 1981; Ruiz 1982). Although the protein contents declined with age, the values at 159 d are still adequate for ruminant production. It is noteworthy, though, that the rate of decline from 159 to 199 d differed between species, and that Rojo Blanco forage contained least protein at 199 d. The decline in protein content indicates that harvest should not be delayed too long; under the conditions for this experiment, the optimum harvest date for L0323 and Rojo Blanco appears to be 159 d, but there was adequate protein in the forage of Red Abundance and NC3 at 199 d.

There may be some constraints to the performance of ruminants grazing sweet potato forage. The high water content of the immature forage (between 7.9 and 11.9%) may limit intake (Minson 1992), although the levels recorded at the later harvest should not impose any such constraint; and ingestion of intact vines may lead to rumen impaction (J. McCosker, personal communication). In addition, Ffoulkes *et al.* (1978) have suggested that sweet potato forage protein is less ruminally degradable than that of some other tropical forages, for instance banana and sugar cane. Nevertheless, the data presented here suggest that sweet potato forage is potentially a very useful ruminant feed, and this conclusion is consistent with the performance of beef cattle recorded by Ffoulkes *et al.* (1978) and Bracker *et al.* (1980). The consistent advantage in productivity and protein content observed in Red Abundance, suggests that late maturing varieties should be preferred for grazing.

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