SHORT NOTES
MARDI Res. Bull. 7, 1 (April, 1979) : 112–117

THE NUTRITIVE VALUE OF CASSAVA (*MANIHOT ESCULENTA* CRANTZ) LEAVES AS A SOURCE OF PROTEIN FOR RUMINANTS IN MALAYSIA

C. DEVENDRA

Key words: Varieties, Cassava leaves, Digestibility, Nutritive value, Sheep.
Accepted for publication on 13th. September, 1978

RINGKASAN

Data bagi pembahagian bahan-bahan kimia daripada 11 jenis daun ubi kayu telah dipersembahkan. Empat daripadanya adalah dari jenis pahit dan 7 jenis manis. Melainkan 'Nitrogen free-extract' tiada kaitan yang nyata antara bahan kimia daun ubi kayu berjenis pahit dengan jenis manis. Daun ubi kayu yang berjenis pahit mempunyai protin kasar yang tinggi. Dalam perhadaman daun ubi kayu berjenis C5 menunjukkan bahawa perhadaman bahan kering adalah sebanyak 49.7 peratus, bahan organic sebanyak 50.0 peratus, protin kasar sebanyak 62.6 peratus dan tenaga perhadaman sebanyak 53.4 peratus. Perhadaman protin kasar adalah tinggi, bersamaan dengan perseimbangan nitrogen yang sebanyak 62.5 peratus daripada peratus pengambilan makanan. Nilai makanan protein kasar yang dihadamkan adalah sebanyak 4.5 peratus, jumlah bahan yang dihadamkan sebanyak 49.6 peratus, tenaga yang telah dihadamkan sebanyak 12.2 MJ/Kg dan tenaga matabolisma sebanyak 10.0 MJ/Kg. Jumlah tenaga untuk menaikkan berat badan adalah sebanyak 3.98 MJ/Kg. Nilai biologi ialah 65.4. Kegunaan daun-daun ubi kayu sebagai punca protin dalam makanan ruminant di Malaysia telah ditegaskan.

INTRODUCTION

Of the feed products from cassava (*Manihot esculenta* Crantz) of value to farm animals, the leaves have been the least exploited especially in diets for ruminants. This lack of interest is associated with four reasons (DEVENDRA, 1977): (1) decreased root yields due to harvesting the leaves, (2) relatively low yield during harvesting at maturity, (3) possibilities of HCN toxicity especially with bitter varieties, and (4) inadequate appreciation of the presence in the leaves of a relatively high crude protein content.

Recently however, due to the escalating prices of feed ingredients especially of preformed proteins, and also the need to ensure that there was adequate "by-pass" proteins that can supplement rumen microbial proteins for production (LENG and PRESTON, 1976), attention is being directed at cassava *(Manihot esculenta* Crantz*)* leaves as a potential source of proteins (see for example MEYRELLES, MACLEOD and PRESTON, 1977a). Realisation of the potential value of these leaves has stimulated much research in the ruminant (ALVAREZ *et al.*, 1977; MEYRELLES, MACLEOD & PRESTON, 1977b, 1977c). Cassava leaves have however been fed to calves in France (GUIN and ANDOUARD, 1910), cattle in Cuba (OSVALDO, 1966) and Madagascar (SEERES, 1969) and as a dry season supplement in Brazil (GRAMACHO, 1973). Very recently, the value of leaves in promoting increased growth response in cattle has been demonstrated in Santo Domingo (MEYRELLES and FERNANDEZ, 1978).

MOORE (1976) was the first to report from studies with beef cattle the potential value of the aerial part of cassava in sugarcane based diets in Colombia, and demonstrated that when planted at a high population density, repeated three to four month cutting intervals is feasible over a total growing period of up to 18 months. MONTALDO (1977) has more recently reported the use of the whole cassava plant as a feed for ruminants in Venezuela.

Cassava leaves are a potential source of low cost protein, and has been used as a source of proteins for humans (TERRA, 1964). Cassava leaves were recently reported to be one of the notable sources in the content of large quantities of essential amino acids in an assessment of 23 plant types (HALL, NAGY and BERRY, 1975). It also contains a high carotene content. The lysine content is high and methionine level low (OKE, 1973). Consequently it has been suggested that cassava leaves can be used to supplement cereals deficient in lysine in animal

feeding. Recently, the economic potential of protein production from cassava foliage in Malaysia has been stressed (WEBB, WHOLEY and HUTAGALUNG, 1978).

In view of these considerations, studies were initiated to assess the chemical compositional characteristics of the available cassava varieties and also digestibility : this paper presents the results of this investigation.

MATERIALS AND METHODS

The techniques used for the balance trial, sampling of feed, faeces and urine and chemical analyses were those that have been previously described (DEVENDRA, 1975).

One digestibility trial was conducted using leaves of variety *C5*, a bitter variety. The leaves were harvested from plants about 10 months age, dried in the sun to reduce HCN levels and stored in air dry bags.

Four indigenous sheep of Malaysia were used for the trial. The animals were in good condition and were drenched with 'Nilverm' on a routine basis. The cassava leaves were fed *ad libitum* and adequate clean drinking water was provided.

RESULTS AND DISCUSSION

(1) Chemical composition

Table 1 presents the chemical composition and mineral content of 11 varieties of cassava found in Malaysia. The leaves of each variety was harvested from 10 months above old plants. Of these, four were bitter varieties *(Black twig, Brazil* 146 56/A, *C5* and *Green twig).*

The crude protein content ranged from 16.2 per cent *(Betawi)* to as high as 27.4 per cent *(Jurai).* The mean crude protein content for the bitter variety was 24.3 per cent and the sweet varieties 22.9 per cent; the bitter varieties appear to have a higher protein content. The crude fibre contents showed considerable variation, from 8.1 per cent *(Ubi ladang)* to 23.2 per cent for *Jurai.* The mean crude fibre content for the bitter varieties was 13.8 per cent compared to 11.0 per cent for the sweet varieties. The gross energy values also showed considerable variation from 15.6 MJ/Kg for *Black twig* to 22.8 MJ/Kg for *Jurai.* The mean values for the bitter and sweet varieties were 18.3 MJ/Kg. A statistical analysis of the mean values between bitter and sweet varieties indicated that except for nitrogen-free extract ($P<0.05$), there were no significant differences.

(2) Mineral content

The highest Ca content of 1.28 per cent was evident for variety *C5,* and lowest 0.55 per cent for *Ubi Puteh I.* On the other hand *C5* recorded the lowest P and Mg content 0.07 and 0.13 per cent while *Llanera* recorded the highest (0.26 per cent) P content. The highest Mg content was noted for variety *Ubi ladang* (0.48 per cent). Data are also given for micro minerals : Na, K, Mn, Fe, Cu and Zn. Relatively high Na and K levels are found for variety *Ubi ladang,* and Fe, Cu and Zn contents for variety *C5.*

(3) Intake

The mean intake of dry matter of cassava leaves was 462 ± 53 g per day. This was equivalent when expressed in terms of mean body weight to 2.3 per cent.

TABLE 1. THE CHEMICAL COMPOSITION AND MINERAL CONTENT OF CASSAVA (*MANIHOT ESCULENTA* CRANTZ) LEAVES
(% dry matter basis)

Variety	D.M.	C.P.	C.F.	E.E.	ASH	N.F.E.	G.E. MJ/Kg	Ca %	P %	Mg %	Na %	K %	Mn ppm	Fe ppm	Cu ppm	Zn ppm
Black Twig*	24.1	23.8	14.0	2.8	5.7	53.7	15.6	0.91	0.14	0.32	0.05	1.25	83	4	4	21
Betawi (Berat)	16.2	22.2	8.9	3.7	5.3	59.9	19.3	1.01	0.19	0.32	0.05	0.49	116	3	7	66
Brazil 146 56/A*	22.9	25.0	20.5	2.6	3.2	48.7	19.5	0.53	0.09	0.22	0.05	0.54	43	8	7	16
C5*	25.0	23.2	22.2	5.0	6.2	43.4	20.9	1.25	0.07	0.13	0	1.93	48	41	13	67
Green Twig*	21.2	25.0	12.3	2.9	5.7	44.1	17.2	0.86	0.22	0.42	0.04	1.54	60	24	10	34
Jurai	27.4	24.1	23.2	1.3	2.5	48.9	22.8	0.61	0.11	0.17	0.04	0.59	37	15	8	19
Llanera	26.6	21.2	8.7	3.9	5.0	61.2	18.9	0.81	0.26	0.23	0.03	1.47	63	8	8	39
Medan (Kekabu)	25.5	22.7	9.7	3.6	5.3	48.7	16.7	0.63	0.07	0.25	0.07	1.19	20	3	11	22
Ubi Puteh I	23.3	23.5	9.4	3.1	5.4	58.6	17.2	0.55	0.20	0.28	0.07	1.22	40	7	9	30
Ubi Puteh II	22.7	24.0	9.2	2.6	5.5	58.7	16.4	0.78	0.25	0.29	0.07	1.38	45	26	10	32
Ubi Ladang (Batang Puteh)	21.7	22.6	8.1	2.9	6.0	60.4	16.8	0.98	0.20	0.48	0.07	1.57	66	14	11	46

*Bitter varieties.

(4) Digestibility

The digestibility of cassava leaves is shown in *Table 2.* The dry matter and organic matter and energy digestibility were relatively low (49.7, 50.0 and 48.7 per cent, respectively). However crude protein digestibility was high (62.6 per cent) and was associated with a high N balance of 62.5 per cent equivalent to about 6 g of nitrogen per day. This high digestibility suggests that the protein component in cassava leaves is very digestible, and represents therefore a potentially important alternative source of proteins for ruminant feeding. Negative Ca and P balances were found, but for Mg a positive balance was recorded.

TABLE 2. APPARENT DIGESTIBILITY OF CASSAVA LEAVES
(Each value is the mean of 4 sheep)

Constituent	Digestibility (%)
Dry matter	49.7
Organic matter	50.0
Crude protein	62.6
Crude fibre	50.3
Ether extract	6.8
Ash	45.8
Nitrogen-free extract	53.4
Energy	48.7
N balance*	62.5
Ca balance*	– ve
P balance*	– ve
Mg balance*	76.7

*As % of intake.

(5) Nutritive value

The determination of digestibility enabled an assessment of nutritive value of individual nutrients including also calorific value *(Table 3).* The DCP value of 14.5% calculated compares with the value of 14.5 to 18.3 per cent reported for sheep by MCDOWELL *et al.*, (1974). However the digestible energy (DE) value of 12.2 MJ/Kg and metabolisable energy (ME) value of 10.0 MJ/Kg appear to be relatively higher to the values of 9.0 MJ/Kg and 7.4 MJ/Kg also reported by MCDOWELL *et al.*, (1974); locational and varietal differences obviously account for the differences. On the other hand the total digestible nutrients (TDN) value estimated in the present trial is comparable to value of 48.7 reported by MCDOWELL *et al.*, (1974).

The net energy for fattening (NEF) was also calculated using the Rostock equation (SCHIEMANN *et al.*, 1971) : $Y = 1.82\ X_1 + 8.39\ X_2 + 1.90\ X_3 + 1.90\ X_4$ where Y = NEF, X_1 = DCP (g), X_2 = digestible crude fat (g), X_3 = digestible crude fibre (g) and X_4 = digestible nitrogen-free extract. The NEF of cassava leaves was found to be 3.90 MJ/Kg. The biological value (BV) was calculated to be 65.4.

TABLE 3. NUTRITIVE VALUE OF CASSAVA LEAVES

Constituent	Value
Digestible crude protein (%)	14.5
Total digestible nutrients (TDN, %)	49.6
Digestible energy (MJ/Kg)	12.25
Metabolisable energy (MJ/Kg)	10.05
Net energy for fattening (MJ/Kg)*	3.98

*Calculated from the Rostock equations published by Schiemann *et al.*, (1971).

The studies together indicated that tapioca leaves are potentially very valuable as a source of protein. Further studies are needed to exploit its value as a forage in practical feeding systems for ruminants in Malaysia.

ACKNOWLEDGEMENTS

The author records his thanks to Cik Enson Hj. Abdul Rahman and Encik S. Nantha Kumaran for technical assistance.

SUMMARY

Data are presented on chemical composition of 11 varieties of cassava (*Manihot esculenta* Crantz) leaves, 4 bitter and 7 sweet varieties. Except for nitrogen-free extract, no statistically significant differences were found in chemical composition between bitter and sweet varieties. The bitter varieties appear to have a higher mean crude protein content. The digestibility of the leaves of variety *C5* showed that the dry, organic matter digestibility, crude protein and energy digestibility were 49.7, 50.0, 62.6 and 53.4 per cent respectively. The crude protein digestibility was noticeably high, and was associated with a relatively high N balance of 62.5 per cent as percentage of intake. The nutritional value determined was 14.5 per cent digestible crude protein (DCP), 49.6 per cent total digestible nutrients (TDN), 12.2 MJ/Kg digestible energy (DE), 10.0 MJ/Kg metabolisable energy (ME) and 3.98 MJ/Kg net energy for fattening. The biological value (BV) was 65.4. The potential of tapioca leaves as a source of protein in diets for ruminants in Malaysia is stressed.

REFERENCES

ALVAREZ, F.J., ALPUCHE, D., SUTHERLAND, T.M. WILSON, A. PRESTON, T.R. (1977). Comparison of cassava forage and *Leucaena lecocephala* as source of protein and roughage on final molasses and urea diets. *Trop. Anim. Prod., 2,* 119 (Abstr.).

DEVENDRA, C. (1975). Studies in the utilisation of rice straw by sheep. I. Optimal level in the diet. *Malays. agric. J., 50,* 169–186.

DEVENDRA, C. (1977). Cassava as a Feed source for ruminants. *Proc. IDRC. Workshop on Cassava as an Animal Feed,* 18–20th April, Guelph, Canada, p. 107–119.

GRAMACHO, D.D. (1973). Contribucao ao estudo quimico – tecnologico de feno da mandioca. Cruz das Almas, Brasil, Bahia, Univ. Federal, Bahia Escola de Agronomia, *Brascan Nordeste Serie Pesquisa 1,* 143–152.

GUIN, A. and ANDONARD, P. (1910). Tapioca leaves for raising calves. *Bull. Soc. Natl. Agric.* (France), 68, 776–779.

HALL, N.T. NAGY, S. and BERRY, R.E. (1975). Leaves for food: protein and amino acid contents of leaves from 23 tropical and sub-tropical plants. *Proc. Florida State Hort. Soc., 88,* 486–490.

LENG, R.A. and PRESTON, T.R. (1976). Sugarcane for cattle production: present constraints, perspectives and research priorities. *Trop. Anim. Prod., 1,* 1–12.

MCDOWELL, L.R. CONRAD, J.H. THOMAS, JENNY, E. and HARRIS, L.E. (1974). *Latin American Tables of Feed composition,* University of Florida, Gainsville, 509 pp.

MEYRELLES, L. MACLEOD, N.A. and PRESTON, T.R. (1977a). Cassava as a source of protein: effect of population density and age at cutting. *Trop. Anim. Prod., 2,* 18–26.

MEYRELLES, L., MACLEOD, N.A. and PRESTON, T.R. (1977b). Cassava forage as a protein source in sugarcane diets for cattle: effect on rumen fermentation of different levels of cassava forage. *Trop. Agric. Trin., 2,* 300–305.

MEYRELLES, L., MACLEOD, N.A. and PRESTON, T.R. (1977c). Effect of two levels of cassava forage in sugarcane supplemented diets on animal performance and rumen fermentation. *Trop. Anim. Prod., 2,* 225–239.

MEYRELLES, A. and FERNANDEZ, DE A. (1978). Supplementation with yucca forage of diets of sugarcane or final molasses. *II. Int. Conf. of Sugarcane in Anim. Prod.*, p. 8 (Abstr.).

MOORE, C.P. (1976). The Utilisation of cassava forage in ruminant feeding. *Int. Seminar on Trop. Anim. Prod.,* Acapulco, Mexico, March 8–12th 1976, 21 pp.

MONTALDO, A. (1977). Whole plant utilisation of cassava for animal feed. *Proc. IDRC. Workshop on Cassava as an Animal Feed,* 18–20th April, Guelph, Canada, p. 95–106.

OKE, O.L. (1973). Leaf protein research in Nigeria. *Trop. Sci., 15,* 139–155.

OSVALDO, P.C. (1966). La yuea (cassava). *Agrotecnia, 2,* 22pp.

SEERES, H. (1969). L'angraissement des zebus dans I region de Tananarive selon la tecnique du boeuf de fosse. *Rev. Elev. Med. Vet. Pays. Trop., 22,* 429–439.

SHIEMANN, R. NEHRING K., HOFFMAN, L., JENTSCH, W. and CHUDY, A. (1971). Energetische futerburwertung and Energinormen. *VEB Deutch Lantwirtschaftsverlag, Berlin.*

TERRA, G.J.A. (1964). The significance of leaf vegetables, especially of cassava in tropical nutrition. *Trop. Geog. Med., 16,* 97–108.

WEBB, B.H., WHOLEY, D.W. and HUTAGAI UNC, R.I. (1978). Protein feed from cassava foliage. *Conf. Technol. for Rural Development,* 24–29th April, K. Lumpur, 34 pp.