Nutrient characterisation and *in vitro* digestibility of grass and legume/browse species - based diets for beef cattle in Vanuatu

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ABSTRACT

Some grasses, Buffalo (Panicum Coloratum), Guinea (Panicum maximum), Setaria (Setaria sphacelata), Embu (Panicum maxum), Elephant (Pennisetum Purpureum), Koronivia (Brachiaria humidicola), and Signal (Brachiaria decumben); and legumes/browses Gliricidia sepium, Glycine wightii, Green desmodium and Leucaena leucocephala grazed by beef cattle in Vanuatu were characterized for crude protein (CP), fibre fractions, macro and micro minerals (phosphorus, calcium, magnesium, potassium, copper, iron, manganese and zinc) and energy. Also in vitro digestibility study was carried out to predict the utilization of available nutrients. Data obtained were discussed in light of whether available nutrients would satisfy requirements of grazing beef cattle of different age and physiological function. The CP of grass and legume/browse species ranged from 7.9–17.8% and 10.5–23.9% respectively. L. leucocephala has a higher CP while Green leaf desmodium had the lowest CP content. DM and NDF were higher (P<0.05) in the grasses while CP was higher in the legume/browse species. Organic matter (OM) within and between the grass and legume/browse species varied. Mean concentrations of calcium (Ca) and phosphorus (P) in the grass species was 5.7 g/kg DM and 2.6 g/kg DM, respectively and this resulted in an average Ca:P ratio of 2.2:1 for the grasses while the legume /browse species had Ca:P ratio of 5.3:1. Ca was low while K was high in the grasses compared to the legume/browse species. Among the micro-minerals Cu was critically low in both the grass and legume/browse species. In vitro DMD, OMD and CPD between and within the grass and legume/browse species were not significantly different (P>0.05) from each other, however NDFD and ADFD were higher (P<0.05) in the grasses than in the legumes/browses. In conclusion, the results of these analyses and the in vitro digestibility study have provided information on nutrients that are adequate and/or inadequate in the grass and legume/browse species components grazed to sustain beef cattle production in Vanuatu. The very low concentration of Cu in both the grass and legume/browse species therefore demonstrates the need to supplement grazing beef cattle with mineral lick blocks to overcome its deficiency.

***Keywords**: Beef cattle, grass, legume/browse, nutrients, in vitro digestibility, Vanuatu*

1 INTRODUCTION

Vanuatu, a Melanesian country is composed of over 80 small-scattered islands with a total land area of 12,278 km^2. The population is approximately 200,000 concentrated on 3 of the major islands with a total landmass of 1.2 M ha of which 41% is arable. Majority of the people depends on agriculture for their livelihood. National export is dominated primarily by copra and beef and to a lesser extent cocoa and timber which contribute 23% of GDP. Subsistence agriculture accounts for 43% of agricultural production and 80% of working age Ni-Vanuatu (indigenous citizens) cultivate their own land for livelihood (Jonah 2004).

Livestock production is one of the major areas in the agricultural sector that plays a very important role in the socio-economic development of the people because it provides meat, milk and other products (Jonah 2004). In Vanuatu, beef cattle production dominates the livestock sector and contributes 12% to GDP and 22% to national exports. Both smallholder and plantation grazers predominantly utilize free-grazing systems based entirely on pasture (native and improved grass). Beef cattle production in Vanuatu is largely dependent on forages (grasses, leaves, twigs and shoots of legumes/browses) which are freely grazed and no concentrate supplements or conserved feeds are used (Mullen, 1999). The Vanuatu Pasture Improvement Project (VPIP) introduced some improved grass species and these plus legume/browse species have average carrying capacity of 2.5 animals per ha and produce an average body weight of about 1kg per day (Loughmann 2001).

Majority of beef cattle are kept under smallholder and plantation grazing systems. Most farms have improved grasses that produce good quality beef, however about 50% of smallholders still use native pasture without legume/browse for grazing (Evans *et al.* 1992 and Loughmann 2001).

Beef cattle production in Vanuatu depends on the quantity and quality of available pastures throughout the year. However, deterioration of available improved and native pastures is due mainly to the decline in legume content; and overgrazing that is always exacerbated in unusually dry periods (Evans *et al.* 1992). Many of the grasses and legumes/browses available in Vanuatu respond differently to range of climatic conditions, sub-optimal soil fertility and management pressure that exist. For example some pastures are limited nutritionally by low crude protein and low levels of sodium (interior pastures), copper and phosphorus (Montmarte and coastal pastures) (Evans *et al.* 1992; Tabi Aga 2005). Vanuatu however, has the potential to establish large areas of highly productive pasture, (Mullen 1999). Quantity and quality; and continuity of feed supply throughout the year promote a favourable level of animal production in any environment. Most tropical grass species have low dry matter digestibility and intake.

During the dry season, when plant growth is highly suppressed, the shortage of forages reduces growth of grazing animals. This also affects requirements and bio-availability of minerals in grazing animals (Aregheore and

Hunter 1999). Furthermore, in the dry season most ruminants reared on grass alone have problems in meeting their maintenance requirements and consequently lose the weight gained during the wet season period (Aregheore 2001). To overcome this situation it is therefore imperative to balance their diet in terms of protein, vitamins and minerals through supplementation with foliage of legume/browse species. Chemical analysis and *in vitro* technique data can be used to predict *in vivo* intake and digestibility of forages (Van Soest 1965). The objectives of this investigation therefore were to characterize available grass and legume/browse species for contents of crude protein, fibre fractions; macro and micro minerals; elucidate whether available nutrients meet the requirements of beef cattle of different age and physiological function in Vanuatu; and also to establish their *in vitro* digestibility.

2 METHOD AND MATERIALS

2.1 SAMPLE PREPARATION

Samples of some grasses namely- [Buffalo (*Panicum Coloratum L.*), Elephant grass (*Pennisetum purpureum schumach*), Signal grass (*Brachiaria decumbers*), Setaria grass (*Setaria anceps*), Embu grass (*Panicum maximum*), Koronivia (*Brachiaria humidicola*) and Guinea grass (*Panicum maximum*)]; and legume/browse species [Leucaena leucocephala (*L. leucocephala*), Glycine (*Glycine wightii*), Gliricidia (*Gliricidia sepium*), Green Leaf Desmodium (*Desmodium intortum cv.green leaf*)] were clipped from standing plant materials to be either grazed or harvested in a manner designed to obtain herbage representative as possible for feeding beef cattle in various sites in Vanuatu. The samples were collected during the dry season period of 2004 (Dry season in Vanuatu spans from May to October and it coincides with the cool season; temperature range of 25–12°C).

These were allowed to air-dry in the shade until the leaves turned brown in colour. They were then placed in separate paper bags, labeled and put in a carton and brought to Samoa through the Quarantine Department. Samples of each species were milled using a simple laboratory mill to pass through 2mm sieve and stored in air-tight plastic containers until required for chemical analyses. Air-drying is the most practical method as it corresponds to the manner in which farmers are likely to manage leaves of legumes/browses as feed supplements or leaves of grasses in a cut-and-carry production systems and is generally recommended (Mueller-Harvey 2001).

2.2 ANALYTICAL PROCEDURES

AOAC (1995) method was used for proximate analysis of samples. All analyses were done in triplicate. Dry matter was determined by drying at 102°C for 24 hours. Ash concentration was determined after ignition at 550°C for 4 hours in a muffle furnace and used to calculate organic matter (OM). Protein was by the micro-kjeldahl procedure (N x 6.25) (Procedure ID Number 954.02). Fibre fractions, neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by the procedures of Van Soest *et al.* (1991). The NDF was assayed with sodium sulfite, without alpha amylase and was expressed with residual ash. Concentrations of hemicellulose were calculated mathematically as the difference between NDF and ADF after nonsequential analysis of NDF and ADF. Gross energy values were determined with a bomb calorimeter (Adiatic bomb, Parr Instrument Company, Moline, IL. USA) and thermochemical benzoic acid was used as a standard.

To detect the minerals grass and browse/legume samples were dry ashed at 600°C for 4 hr, followed by wet digestion of 0.5 g in 15 ml of 2:1 (v/v) mixture of (HNO_3/$HClO_4$), diluted with distilled water and made up to 50 ml. An atomic absorption spectrophotometer (GBC 908 AA, Scientific Equipment Pty Ltd, Dandenog, Victoria, Australia) was used to detect Ca, Mg, P, Mn, Zn, Cu and Fe, and the analytical wavelength used for Ca was 422.7 mm, Mg 285.2 mm; P. 660 nm and K, 766.5 nm, while K was determined using a flame photometer (Ciba-Corning Flame Photometer 410) as described in Daly and Wainiqolo (1993).

The *in vitro* digestibility of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) was determined using the method of Tilley and Terry (1963) as modified by Aufrere and Michalet-Doreau (1988). In brief, air-dried samples were weighed into 50 ml centrifuged tubes with screw cap top in duplicate and incubated in water bath of 39°C over a period of 48 hrs. Four blanks serve as controls. A forage (leucerne hay) sample of known *in vitro* value with a known DM ruminal disappearance was included in each batch of incubations. Rumen cannulated sheep fed a leucerne hay diet was used in the *in situ* study to supply innoculum for the *in vitro* digestibility study. Standard procedures were followed in the calculation of DM, N, NDF and ADF digestibility.

2.3 STATISTICAL ANALYSIS

The chemical composition and *in vitro* data of the grass and legume/browse species were statistically analyzed using analysis of variance (ANOVA) and significant difference between means were compared using Tukey's t-test, (Steel and Torrie 1980).

3 RESULTS

The crude protein (CP) content in the grass species ranged from 7.9–17.8%. Setaria grass had the highest concentration of CP compared to Guinea, Embu, Buffalo, and Koronivia and Signal grasses, but this was significantly different ($P<0.05$) from other grass species (Table 1). CP content of legume/browse species ranged from 10.5–23.9%. *Leucaena leucocephala* a tree legume has a higher CP content while Green leaf desmodium had the lowest CP content. There was no significant difference ($P>0.05$) between Glycine and *Gliricidia sepium* in CP content. Comparatively, the CP content in legume/browse species was on the average, significantly higher than that in the grass species (Table 1).

Table 1. Proximate chemical composition of grass and legumes/browses species (expressed on dry matter basis)

	Nutrients*						
	DM	CP	OM	NDF	ADF	Hemi	GE (MJ/kg)
Grass species							
Buffalo grass	86.4	10.1	88.8	53.5	42.8	10.7	13.4
Guinea grass	70.6	11.8	75.2	56.5	45.3	11.2	14.8
Setaria grass	87.9	17.8	88.8	64.5	45.3	19.2	13.5
Embu grass	84.7	10.1	78.8	63.4	44.3	19.1	14.0
Elephant grass	70.1	13.1	79.9	64.4	41.5	22.9	13.1
Koronivia grass	78.6	10.3	75.0	62.5	44.4	18.1	14.7
Signal grass	74.0	7.9	75.0	64.6	52.1	12.5	14.6
Mean	78.9a	11.5a	80.9	61.3a	45.1	15.8	14.0
Legume/browse species							
Gliricidia	58.7	19.8	66.4[1]	47.7	25.3	22.4	14.0
Glycine	57.3	22.2	74.8[2]	55.1	36.3	18.8	13.8
Green leaf desmodium	48.6	10.5	51.3[1]	-	-	-	15.0
Leucaena	50.8	23.9	74.6[2]	48.1	32.2	15.9	16.4
Mean	53.9b	19.5b	71.9	50.3b	31.3	19.0	14.8

*DM, Dry matter; CP, Crude protein; OM, Organic matter; NDF, Neutral detergent fibre; ADF, Acid detergent fibre; Hemi., Hemicellulose; GE, gross energy.
- data not available (insufficient Green leaf desmodium sample for NDF and ADF analyses).
a, b, Means in the same column followed by different letters are different at P = 0.05 using Tukey's t-test.
[1,2] Means in the same column followed by different numbers are different at P = 0.05 using Tukey's t-test.

Organic matter (OM) in the grass species varied with no evidence of significant differences (P>0.05), while OM in the legume/browse species varied with some evidence of significant differences (P<0.05). NDF was higher in the grass species (P>0.05), however, there was no significant difference between the grasses and legume/browse species (p>0.05) in hemicellulose. Gross energy (MJ/kg DM) content of grass and legume/browse species were 13.1–14.7; and 13.8–16.4 MJ/kg DM, respectively and there was no significant difference (P>0.05) between the species.

The mean concentration of DM, CP, OM, ADF, ADF and hemicellulose in the grass and legume/browse species (Table 1) indicates that CP was higher in the legume/browse species, while DM and NDF were higher (P<0.05) in the grass species. However, the concentrations of OM, ADF, hemicellulose and gross energy were close in both the grass and legume/browse species.

Macro mineral concentration in the grass and legume/browse species is presented in Table 2. Koronivia grass had a higher P value than the other grasses but it was not significantly different (P>0.05) from the P value of other grasses except Guinea grass that had the lowest P at 1.5 g/kg. Calcium (Ca) was higher in Embu followed by Guinea grasses however, the difference between Embu/guinea grasses and other grasses were not statistically significant (P>0.05). Buffalo and signal grasses had higher magnesium (Mg) content, and this was not significantly different from the other grasses. Potassium (K) was higher in Setaria grass and this was significantly different (P<0.05) from other grass species.

The legume/browse species had Phosphorus (P) content that ranged between 2.0–3.6 g/kg. Calcium (Ca) was high in *Gliricidia* compared to other browse species. Magnesium (Mg) content of Gliricidia and Glycine were close in value than Leucaena and Green leaf desmodium. Potassium (K) was significantly higher (P<0.05) in Glycine than in Green leaf desmodium, Leucaena and Gliricidia. Except for Ca and K, there was no significant difference (P>0.05) in the concentration of P and Mg between the legume/browse species.

Mean concentrations of calcium (Ca) and phosphorus (P) in the grass species was 5.7 g/kg DM and 2.6 g/kg DM, respectively and this resulted in an average Ca:P ratio of 2.2:1 for the grasses while the legume /browse species had Ca:P ratio of 5.3:1.

Mean concentration of the macro minerals indicates that the grass species have low Ca but high K compared to the legume/browse species, however available levels are high enough to satisfy the requirements of beef cattle.

Table 3 presents the micro mineral concentration of the grass and legume/browse species. Iron (Fe) was significantly higher (P<0.05) in Embu grass followed by Setaria and Koronivia grasses. Buffalo grass had the lowest Fe content. Manganese (Mn) was significantly higher (P<0.05) in Setaria grass than in other grasses. Copper (Cu) was numerically higher in Setaria than in other grasses. Zinc (Zn) was higher in Koronivia followed by Setaria grass while Buffalo grass has the lowest Zn content among the grasses.

Table 2. Macro-mineral composition of some grass and legume/browse species from Vanuatu (on dry matter basis)

	P (g/kg)	Ca (g/kg)	Mg (g/kg)	K (g/kg)
Grass species				
Buffalo grass	2.5	4	2.9	31.2[2]
Guinea grass	1.5	8.2	1.6	21.1[2]
Setaria grass	3.2	5.7	1.8	75.7[1]
Embu grass	2.3	9.5	1.9	33.9[2]
Elephant grass	3.2	5.2	1.1	37.3[2]
Koronivia grass	3.6	4	2	21.4[2]
Signal grass	2.7	3.6	2.3	27.6[2]
Mean	2.6	5.7a	1.9	35.5a
Legume/browse species				
Gliricidia	2.0	19.2[1]	2.6	19.4[2]
Glycine	3.6	12.1[2]	2.4	33.6[1]
Leucaena	2.2	12.2[2]	1.9	16.7[2]
Green desmodium	2.5	12.1[2]	1.1	11.9[2]
Mean	2.6	13.9b	2.0	20.2b
Beef cattle requirements (g/kg)*	1.9	1.9	0.5	6

*NRC (1981, 1984, 1998, 2000, 2001).
A, b, Means in the same column followed by different letters are different at P = 0.05 using Tukey’s t-test.
[1,2] Means in the same column followed by different numbers are different at P = 0.05 using Tukey’s t-test.

Table 3. Micro-mineral composition of some grass and legume/browse species from Vanuatu (on dry matter basis)

	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Grass species				
Buffalo grass	61.8[3]	23.9[2]	4.2	1.6[3]
Guinea grass	88.6[3]	24.7[2]	5.5	18.7[2]
Setaria grass	148.9[2]	108.7[1]	8.3	44.5[1]
Embu grass	260.8[1]	28.7[2]	5.7	39.9[1]
Elephant grass	95.1[3]	19.4[2]	7.1	20.2[2]
Koronivia grass	118.9[2]	18.3[2]	5.5	46.2[1]
Signal grass	80.4[3]	17.7[2]	4.2	23.4[2]
Mean	122.1a	34.5a	5.8	27.8a
Legume/browse species				
Gliricidia	117.9[2]	27.8	6.4	14.8[2]
Glycine	141.5[2]	28.6	11.3	36.9[1]
Leucaena	131.7[2]	26.9	6.6	18.5[2]
Green leaf desmodium	217.6[1]	21.8	5.4	7.3[3]
Mean	152.2b	26.3b	7.4	19.4b
Beef cattle requirements (mg/kg)*	50	20	40	20

*NRC (1981, 1984, 1998, 2000, 2001).
a, b, Means in the same column followed by different letters are different at P = 0.05 using Tukey's t-test.
[1,2, 3] Means in the same column followed by different numbers are different at P = 0.05 using Tukey's t-test.

Green leaf desmodium was higher in Fe content than other legume/browse species (P<0.05). Manganese (Mn) was similar among the legume/browse species. Cu was numerically higher in Glycine compared to the other legume/browse species, while Zinc (Zn) was significantly higher (P<0.05) in Glycine than in Leucaena and Gliricidia and lowest in Green leaf desmodium.

The mean concentration of micro minerals in both the grass and legume/browse species indicates that the legume/browse species had higher Fe and Cu while Mn and Zn were high in the grass species. In both the grass and legume/browse species Cu was very low. However, except for Cu, other micro minerals in the grass and legume/browse species would satisfy the requirements of beef cattle during the dry season period in Vanuatu.

Data on *in vitro* digestibility of grass and legume/browse species is presented in Table 4. *In vitro* DMD, OMD and CPD between and within the grass and legume/browse species were not significantly difference from each other, however NDFD and ADFD were higher in the grasses than the legume/browse species at a significant level (P<0.05).

Table 4. *In vitro* digestibility of nutrients in grass and browse species based diets for beef cattle in Vanuatu

	Nutrients*				
	DMD	OMD	CPD	NDFD	ADFD
Grass species					
Buffalo grass	49.6	47.4	52.9	46.4	45.9
Guinea grass	42.2	41.2	62.1	48.6	46.3
Setaria grass	53.8	52.0	62.9	52.4	53.8
Embu grass	43.1	40.4	57.3	42.1	46.4
Elephant grass	55.6	52.2	62.5	58.3	57.7
Koronivia grass	54.3	53.2	68.7	57.3	58.5
Signal grass	41.6	40.2	52.6	52.8	56.5
Mean	48.6	46.7	59.9	51.1a	52.2a
Browse species					
Gliricidia sepium	48.4	46.1	54.5	43.9	42.7
Glycine	43.8	41.5	54.4	44.5	45.9
Leucaena leucocephala	56.8	53.3	57.7	47.5	44.7
Mean	49.7	46.9	55.5	45.3b	44.4b

*DMD, Dry matter digestibility; OM, Organic matter digestibility; CPD, Crude protein digestibility; NDFD, Neutral detergent fibre digestibility; ADFD, Acid detergent fibre digestibility.
a, b, Means in the same column followed by different letters are different at P = 0.05 using Tukey's t-test.

4 DISCUSSION

The quality of forage reveals the level of nutrient composition, palatability and intake, digestibility, anti-nutritional factors and animal production performance. Forages constitute the key feed component in beef cattle diets and forages of varying quality support different levels of production. The CP content of the grass and browse/legume species is consistent with values reported by (Aregheore 2004, 2005) for grass and browse/legume species from other Pacific island countries (PICs). Except for signal grass, the CP of other grass and browse/legume species is higher than 9.5% CP stipulated as adequate to meet the requirements of beef cattle of different age group and physiological state (NRC 1985).

However it is suggested that farmers in Vanuatu should include a legume component in pasture used for grazing or cut-and carry production system because legumes improves intake (Siebert and Kennedy 1972); and provide a ration which is better. Nutritionally, mixtures are more effective than monocultures at providing the energy:protein ratio required for optimum livestock performance (Aregheore *et al.* 2006).

The concentration of OM, NDF, ADF and hemicellulose in the grass species is consistent with values reported for tropical grass species (Van Man and Wiktorsson 2003; Aregheore *et al.* 2006). OM, NDF, ADF and hemicellulose in the legume/browse species are similar to values reported by Topps (1992); Mandal (1996); Apori *et al.* (1998); Balogun *et al.* (1998) and Lukhele and van Ryssen (2003) for tropical legume/browse species. Forage is important in the sense of providing fiber to ruminants. Inadequate levels of dietary fiber are associated with low milk fat, rumen acidosis and dietary inefficiency (Saman Abeysekara 2003). Gross energy content in the grass and legume/browse species are consistent with values reported by Butterworth (1964) for tropical forages.

The P content in Guinea grass was low, however, other grass species would satisfy the macro mineral requirements of tropical beef cattle (McDowell *et al.* 1983). Macro-mineral values are higher than values earlier reported by Evan *et al.* (1992) for similar grass species in Vanuatu and Aregheore (2004) for other PICs. Based on critical macro mineral requirement levels, the macro minerals in both the grass and legume/browse species meet the requirements of tropical beef cattle of different age and physiological state (McDowell *et al.* 1983). Overall the macro mineral contents of the grass and legume/browse species are higher than average requirements of beef cattle. This therefore demonstrates that the consumption of any of the grasses or legumes/browses on a single basis can satisfy most of the mineral requirements of beef cattle in Vanuatu for growth, reproduction, lactation and maintenance during the dry season.

With the exception of Cu, other micro minerals in the grass species are subsequently higher than the critical requirement levels for tropical beef cattle (McDowell *et al.* 1983; Mpofu *et al.* 1999). Also, the values are higher than those reported for tropical grass and legume/browse species (Little *et al.* 1988; and Kabaija and Little 1991). However, the low Zn content in buffalo grass indicates that beef cattle reared on it alone would need to be supplemented to overcome Zn deficiency.

The range of macro and micro minerals in the grasses and legumes/browses are within the range reported by Youssef and Brathwaite (1987) in Trinidad and Aregheore and Singh (2003) for similar legumes/browses from other PICs. However, the very low concentration of Cu in both the grass and legume/browse species demonstrates the need to supplement grazing beef cattle with mineral like blocks to overcome Cu deficiency.

Differences and similarities observed between and within the grass and legume/browse species in macro and micro minerals might be due to forage cultivar and stage of maturity at harvest; and secondary environmental factors such as soil type, fertility, day length, temperature during plant growth and season of the year. The above factors have been identified to contribute to influence forage quality in terms of nutrient availability.

In ruminant production, the feeding value of forages depends on the balance between available nutrients components of the forage, the digestibility of such nutrients and the quantity of the nutrients ingested by the animal (Seoane *et al.* 1983; Matlebyane 2005). Unlike concentrate feeds there is less information on *in vitro* digestibility characteristics of forages, which form the bulk of most cattle diets.

In vitro DMD and OMD in the grass species falls within values reported for tropical grasses (Reid *et al.* (1973). The CP, NDF and ADF digestibilities are also consistent with values reported for tropical grass species by Reid *et al*. (1973); and Van Man and Wiktorsson (2003).

In vitro DMD and OMD of the browse species are similar to values reported by Msangi and Hardesty (1993) and Lukhele and van Ryssen (2003) for tropical legume/browse species. The non-significant difference between the grasses and legume/browse species in DMD and OMD contradicts Terry and Tilley (1964) who observed differences in the *in vitro* DMD and OMD between forages. The DMD and OMD values reported in this trial are lower than values reported for tropical browse species by Mokoboki *et al.* (2002) in South Africa.

The importance of DMD is acknowledged, especially for the escape of true protein from the rumen (Van Soest *et al.* 1987) and this has influence on CPD. In this study the grass species were have high CPD than the legume/browse species. Generally nitrogen digestibility in the diets of cattle may be influenced by the choice of forage species and the presence of condensed tannins in some legume/browse species may result in low protein degradability (Cassida *et al.* 2000).

The CPD in the legume/browse species was above 50% and this seems to indicate low levels of anti-nutritive factors (polyphenolics). The *in vitro* digestibility of CP, NDF and ADF in both the grass and legume/browse species is higher than the degradability necessary to provide maintenance requirement of adult ruminant livestock (NRC 1985) however their IVDMD and IVOMD were less than 50% (Table 4).

5 CONCLUSION

Beef production in Vanuatu strictly relies on forages (grass and legume/browse species) and is not supplemented with concentrate and farmers have been able to utilize available forages for beef production on a sustainable and profitable scale because available forage are persistent and productive. The success and sustainability of the beef industry in Vanuatu amongst other factors is due to the management and utilization of available forages.

Except for low CP content in signal grass, other grass species have CP concentration above the level suggested as adequate to meet the requirements of beef cattle (McDowell 1985; NRC 1989). Consequently, data on the nutrient characterization of the grass and legume/browses species indicate that they have adequate nutrients to meet the requirements of beef cattle and this is consistent with Van Soest (1965) who reported that the nutritive value of forage can be determined by their chemical composition. Based on available data (Table 1) it could therefore be adduced that the grass and legume/browses species contained adequate nutrients to meet the requirements of beef cattle of different age group, size and physiological state during the dry season in Vanuatu.

In conclusion, the results of the analyses and the *in vitro* digestibility study have provided information on nutrients that are adequate and/or inadequate in the grass and legume/browse species components grazed by beef cattle to sustain production in Vanuatu. The very low concentration of Cu in both the grass and legume/browse species therefore demonstrates the need to supplement grazing beef cattle with mineral lick blocks to overcome its deficiency.

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