COMPOSITION AND DIGESTIBILITY OF INDIGENOUS GRASSES IN THE HARDVELD OF BOTSWANA DURING THE DRY SEASON

COMPOSICIÓN Y DIGESTIBILIDAD DE GRAMÍNEAS NATIVAS DE BOSTWANA EN LA ESTACIÓN SECA

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PALABRAS CLAVE ADICIONALES

Pastos. Composición nutritive. Sebele.

SUMMARY

Available grass species in Sebele ranges were analysed in June, August, October and December of 1999. The mean DM contents were 61.28±1.346, 87.67±0.789, 76.46±0.534 and 64.73±0.453 percent with significance between species. The mean CP was 8.36±0.257, 4.58±0.189, 2.11±0.078 and 2.62±0.104 percent with significant difference between species for all the months.The NDF and ADF contents did not change in these months. The DMD was 50.77±0.258, 41.54±0.497, 44.09±1.586 and 49.14±0.145 percent. It was concluded that the DM, NDF and ADF of all grasses increased, while CP, DMD and mineral content reduced, during dry season.

RESUMEN

Las especies gramíneas de Sebele, fueron analizadas en junio, agosto, octubre y diciembre de 1999. Los contenidos de materia seca (DM) fueron 61,28±1,346; 87,67±0,789; 76,46±0,534 y 64,73±0,453 p.100, con diferencias entre especies. La proteína bruta (CP) fue 8,36±0,257; 4,58±0,189; 2,11±0,078 y 2,62±0,104 con diferencias significativas entre especies todos los meses. NDF y ADF no cambiaron en ese tiempo. La digestibilidad de la materia seca (DMD) fue 50,77±0,258; 41,54±0,497; 44,09±1,586 y 49,14±0,145 p.100. Se concluye que aumentó el contenido de DM, NDF y ADF y se redujo el de CP, DMD y minerales durante la estación seca.

INTRODUCTION

The greater part of the Sebele rangeland is covered with grasses in combination with forest trees, woodland trees, or shrubs or as open savanna grassland areas. Numerous factors affect the type of grassland to be found in a given area; the annual rainfall, which in Botswana is generally less than 750 mm; the soil type, which for the most part is sub-desert sand or at least of a sandy nature, and the influence of man, such as the veld burning and overgrazing (Field, 1976). Cattle kept by traditional farmers in

Botswana relies almost solely on production of fodder from the natural rangelands, and is likely to do so for many decades to come. Thus to maintain a viable cattle industry it must be first maintained rangelands in a good condition. Due to overstocking and mis-management, large areas of Botswana's grasslands are now in poor conditions.

The nutritive value of a forage refers to its chemical composition, digestibility and the nature of digested products; the amount of forage consumed by an animal affects the total nutrient intake and therefore the animal response. Various factors such as acceptability, presence of undesirable substances, rate of passage and availability of forage, influence consumption by animals. Thus assessment of herbage quality involves an integrated evaluation of its nutritive value and its level of consumption (Chheda and Cowder, 1982). The chemical composition of grass is greately influenced by the stage of growth of the plants, the botanical composition of the sward, the nutrient status of the soil, the climate and the management of the sward (Tribe *et al.,* 1963). In general therefore, the composition of pasture dry matter is very variable (Ferguson, 1963).

Limited work on chemical composition, nutritional value, intake and extremely limited work on palatability of grasses is available, so the main asset of this study is to include data on the nutritive value of a wide range of native range grasses.

Table I. *Meteorological data, 1999.* (Datos meteorológicos de 1999).

	Mr	Rh	T max	T min
June	0.0	67	24.4	6.3
August	0.0	57	26.6	8.1
October	2.8	54	30.9	15.4
December	43.4	69	34.1	19.2

Mr= Month rainfall (mm); Rh= Relative humidity (percent); T= Temperature (°C).

MATERIALS AND METHODS

Grass species shown in **table II** were sampled (3 replicates) every two months from June to December 1999 (**table I** shows meteorological data).

The samples were hand clipped at grazing height from the Sebele ranges, collected in brown sampling bags, weighed and oven dried at 60 °C for 72 hours. The dried samples were weighed (to determine DM), milled through a 2.5 mm screen, labelled and stored. Chemical analysis (ash, crude protein and detergent fibre) were done in three replicates using procedures of AOAC (1995). Crude protein was determined by using the Kjeldahl method: digestion for six hours with 20 ml of concentrated sulphuric acid plus selenium mixture and then allowed to cool for 40-60 minutes. 100 ml of distilled water were added to each digest and then left overnight. The samples were then distilled and titrated to get the nitrogen content. The protein content was calculated as N multiplied by 6.25. Minerals were determined with flame photometer (K, Na) or atomic spectrometer (Ca, Cu, Mg, Fe, Zn, Mn). Dry matter true digestibility was determined by the *in vitro* method: the samples

were put in the bottles with 400 ml of rumen liquor from a fistulated steer and a mixture of buffer solutions A and B, and heated in a daisy incubator at 39°C for forty-eight hours. Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined by methods of Goering and Van Soest (1970). Ash content was determined by ashing in a muffle furnace at 550°C for 6 hours.

The data were subjected to analysis of variance using SAS and the means within and between grass species were compared using the Duncan's New Multiple Range Test.

RESULTS

In June 1999 **(table II)**, the dry matter content shows some difference thus ranging from 32.64 for *C.ciliaris* to 78.38 percent for *H.contortus.* The crude protein ranges from 4.87 for *H. contortus* to 16.03 percent for *C. ciliaris* ($p<0.05$). The NDF and ADF were not different between the species. The IVTD is ranging from 39.6 for *D. cinerea* to 60.4 for *B. insulpta*. The two species are significantly different from each other and to other species. Ash content averages at 9.94 percent.

It seems **(table III)** to have high content of K, the highest being *E. rigidor* with 42.29 and lowest being *H. contortus* with 4.81 g/kg, there is significant difference between the species. The Na content is almost the same for all grasses and it is generally low. The Ca content is fairly high, *D. cinerea* being the highest with 14.02 g/kg and *E. rigidor* being the lowest with 1.05. The Mg content ranges from

Table II. *Nutritive composition (percent) of locally available grasses collected in June 1999.* (Composición nutritiva (p.100) de las gramíneas locales disponibles en junio de 1999).

Samples	DM	CP	NDF	ADF	ASH	IVTD
Panicum maximum	49.8±0.35^{b}	9.72±1.83^{a}	68.8±0.66^{a}	39.3±1.40^{a}	11.38±0.38^{a}	52.2±0.39^{b}
Eragrostis rigidor	72.40±0.74^{a}	5.11±0.35^{b}	74.3±0.17^{a}	43.4±0.76^{a}	7.00±0.92^{b}	45.6±0.82^{b}
Schimidta pappophoroides	63.45±0.52^{a}	8.97±1.02^{a}	73.3±0.23^{a}	43.7±0.13^{a}	10.05±1.12^{a}	47.6±1.32^{b}
Brachiaria nigropedata	63.78±0.53^{a}	8.35±0.93^{a}	74.5±1.28^{a}	39.0±0.62^{a}	13.95±0.62^{a}	55.0±0.57^{b}
Urochloa trichopus	51.00±0.43^{b}	8.50±0.12^{a}	67.6±0.47^{a}	42.1±0.07^{a}	16.58±0.48^{a}	58.0±0.79^{b}
Digitaria milangiana	63.28±0.49^{a}	7.25±0.10^{a}	70.2±0.63^{a}	44.5±0.67^{a}	7.70±0.41^{b}	50.2±1.05^{b}
Cenchrus ciliaris	32.64±0.27^{b}	16.03±0.42^{a}	64.2±0.02^{a}	35.5±0.78^{a}	11.04±0.67^{a}	57.6±0.63^{b}
Eragrostis lehmanniana	51.98±0.44^{b}	7.76±0.19^{a}	72.9±0.77^{a}	44.5±0.51^{a}	10.68±1.37^{a}	50.2±0.48^{b}
Eragrostis superba	53.11±0.47^{b}	8.36±1.53^{a}	76.4±0.52^{a}	42.5±1.27^{a}	9.51±0.74^{a}	50.2±0.78^{b}
Rhyncelytrium repens	68.07±0.36^{a}	5.23±0.57^{b}	76.1±0.89^{a}	49.5±0.92^{a}	8.28±0.20^{b}	53.4±1.82^{b}
Heteropogon contortus	78.38±0.85^{a}	4.87±0.65^{b}	76.0±1.52^{a}	47.8±0.78^{a}	7.50±0.54^{b}	44.6±0.89^{b}
Cynodon dactylon	69.54±0.37^{a}	8.05±1.25^{a}	75.6±0.38^{a}	39.4±0.35^{a}	9.19±0.94^{a}	43.4±0.56^{b}
Bothriochloa insculpta	66.83±0.55^{a}	7.73±0.83^{a}	74.6±0.65^{a}	48.7±0.52^{a}	9.86±1.47^{a}	60.4±0.83^{a}
Anthephora pubescens	70.40±0.45^{a}	7.88±0.37^{a}	72.2±0.52^{a}	43.8±0.73^{a}	9.37±0.28^{a}	53.6±0.17^{b}

Key: ^{abc} means with different superscripts along the same column are significantly different at $p<0.05$.

Table III. *Mineral composition of locally available grasses collected in June 1999.* (Composición mineral de las gramíneas locales disponibles en junio de 1999).

Samples	Major minerals (g/kg)					Minor minerals (mg/kg)		
	Ca	P	K	Na	Mg	Cu	Fe	Mn
P. maximum	5.07^{b}	0.78^{a}	16.30^{c}	0.46^{a}	3.19^{a}	7.00^{a}	626^{b}	4.00^{b}
E. rigidor	1.05^{c}	0.51^{a}	42.29	0.081^{a}	0.52^{d}	6.00^{a}	376^{c}	2.00^{b}
S. pappophroides	2.95^{c}	0.81^{a}	8.78^{c}	0.27^{a}	1.16^{c}	7.00^{a}	756^{b}	2.00^{b}
B. nigropedata	1.75^{c}	0.71^{a}	9.28^{c}	0.14^{a}	1.22^{c}	7.00^{a}	1066^{a}	58.00^{ab}
U. trichopus	4.89^{b}	1.13^{a}	14.44^{c}	1.02^{a}	2.36^{b}	9.00^{a}	1566^{a}	71.00^{ab}
D. melagiana	2.39^{c}	0.72^{a}	11.32^{c}	0.17^{a}	1.37^{c}	7.00^{a}	606.00^{b}	57.00^{ab}
A. pubescence	3.37^{b}	1.31^{a}	11.32^{c}	0.26^{a}	1.23^{c}	7.00^{a}	476.00^{c}	3.00^{b}
C. ciliaris	5.74^{b}	1.27^{a}	27.79	0.28^{a}	1.67^{c}	7.00^{a}	186.00^{d}	2.00^{b}
E. lehmaniana	2.42^{c}	1.21^{a}	10.29^{c}	0.18^{a}	1.52^{c}	7.00^{a}	276.00^{d}	8.00^{b}
E. superba	5.69^{b}	1.81^{a}	9.28^{c}	0.16^{a}	1.17^{c}	11.00^{a}	346.00^{c}	11.00^{b}
R. repens	3.99^{b}	1.28^{a}	BDL	0.15^{a}	1.79^{c}	6.00^{a}	206.00^{d}	10.00^{b}
H. contortus	3.31^{b}	0.54^{a}	4.81^{d}	0.097^{a}	1.40^{c}	6.00^{a}	46.00^{e}	BDL
C. dactylon	4.41^{b}	0.72^{a}	9.79^{c}	0.18^{a}	1.79^{c}	9.00^{a}	236.00^{d}	43.00^{ab}
B. insulpta	3.89^{b}	0.47^{a}	6.28^{d}	0.17^{a}	1.69^{c}	8.00^{a}	BDL	BDL

Key: ^{abcde} means with different superscripts along the same column are significantly different.

3.49 for *D. cinerea* to 0.52 g/kg for *E. rigidor*. Generally the Mg content is lower than the Ca which is good since Mg is associated with Ca utilization. The P content is fairly low.

Fe was higher than all the other minor minerals thus ranging from 46 mg/kg in *H. contortus* to 1566 for *U. trichopus* ($p<0.05$). The Cu content (6-11 mg/kg) was similar in all species. The Mn content shows some difference between the grass species, *D. cinerea* being the highest with 105 mg/kg and *E. rigidor, S. pappophroides* and *C. ciliaris* being the lowest with 2 mg/kg.

The DM content in August **(table IV)** seems to be higher than that for June and is similar for all species averaging at 87.67 percent. The CP content decreased in August with an average of 4.58 percent ranging from 8.89 percent for *C. ciliaris* and 2.36 *for E. lehmaniana.* The NDF (increased as compared to June) averaged 75.27 percent and ADF 45.20 percent. The IVTD show some significant difference (35.80 for C. *ciliaris* and 53.40 percent for C. *virgata*), on average the digestibility (41.54 percent) has decreased. The ash content averages 11.17 percent.

The Ca content **(table V)** is significantly different between the grass species, ranging from 2.04 g/kg for E. rigidor and *C. ciliaris* to 10.75 for *B. maglothi.* In general there is a difference in Ca content between the June and August samples. Also the August samples have higher K than other major minerals, *B. nigropedata* being the highest with 14.56 and *A. congesta* being the lowest with 2.22 g/

kg. Na is generally low in all the grass species, P(0.62-1.61 g/kg) and Mg (0.62-1.61 g/kg) are fairly low in all the grasses with significant differences between species. The Cu content (1-3 mg/kg) is reduced as compared to June samples with no difference between species. Fe (from 79 for *H. contortus* to 598 mg/kg for *E. superba)* and Zn (148.16 mg/kg in *U. trichopus* to 2.72 in *A. congesta*) were higher than all the other micro minerals. There was a significant difference between species. Mn content ranges from 1.00 mg/kg for *E. superba* to 28.00 for *C. virgata*. Generally the Fe and Mn content were lower as compared to June samples.

The DM content in October **(table VI)** ranges from 42.65 percent for *E. superba* to 93.83 for *S. pappophroides*, it shows some difference between the species, averaging at 76.46 percent lesser than August but higher than June samples. The CP averages 2.12 percent with no significant difference between species.The NDF (averaging at 74.09 percent) is lower than August but higher than June samples and shows no significant differences between species. The ADF ranges from 39.90 percent for *E. superba* to 52.10 for *C. ciliaris* with an average of 43.03 percent. The ash content averages at 11.69 percent (from 12.75 percent for *C. virgata* to 5.00 for *E. scorperium*). The IVTD ranges from 39.20 percent for *E. superba* to 65.40 percent for *D. melagiana.*They were significantly different.

Table IV. *Nutritive composition (percent) of locally available grasses collected in August 1999.* (Composición nutritiva (p.100) de las gramíneas locales disponibles en agosto de 1999).

Samples	DM	CP	NDF	ADF	ASH	IVTD
P. maximum	86.47±0.12^{a}	6.18±0.74^{a}	70.80±0.82^{a}	45.50±0.42^{a}	8.25±0.50^{a}	51.00±0.34^{a}
E. rigidor	84.96±0.37^{a}	4.29±1.20^{b}	78.40±0.39^{a}	44.90±0.11^{a}	5.50±0.95^{b}	39.60±0.40^{a}
E. scorperium	87.18±0.94^{a}	6.16±0.46^{a}	75.30±0.92^{a}	46.50±0.30^{a}	9.50±0.18^{a}	50.22±0.22^{a}
B. nigropedata	95.12±0.52^{a}	4.62±0.45^{b}	70.80±1.78^{a}	45.10±0.41^{a}	13.50±0.63^{a}	50.00±0.16^{a}
U. trichopus	90.39±0.59^{a}	4.67±0.80^{b}	80.60±0.12^{a}	48.30±0.50^{a}	9.50±0.27^{a}	44.80±0.23^{ab}
D. melagiana	95.68±0.45^{a}	5.22±0.16^{b}	66.50±0.12^{a}	50.60±0.17^{a}	8.00±0.45^{a}	43.61±0.26^{ab}
B. maglothi	91.23±0.70^{a}	8.15±0.35^{a}	68.20±0.49^{a}	44.00±1.43^{a}	11.50±0.61^{a}	50.40±0.81^{ab}
C. ciliaris	78.80±1.08^{a}	10.80±0.14^{a}	80.00±0.44^{a}	51.70±0.65^{a}	7.00±0.24^{a}	35.80±0.23^{b}
E. lehmaniana	90.50±0.73^{a}	2.36±0.44^{c}	82.70±0.67^{a}	50.60±0.11^{a}	5.25±0.17^{b}	45.60±0.97^{ab}
E. superba	76.74±1.52^{a}	4.05±0.21^{b}	77.40±0.44^{a}	44.50±0.35^{a}	6.00±0.43^{b}	41.40±0.18^{ab}
R. repens	90.99±0.27^{a}	4.04±0.46^{b}	72.60±0.39^{a}	47.00±0.09^{a}	7.00±0.73^{a}	44.20±0.47^{ab}
A. congesta	93.38±0.62^{a}	2.79±0.34^{c}	79.50±0.32^{a}	52.30±0.08^{a}	6.50±0.45^{b}	46.00±0.92^{ab}
H. contortus	81.21±0.53^{a}	3.80±0.38^{b}	83.10±0.22^{a}	52.80±0.44^{a}	7.50±0.18^{a}	44.20±0.19^{a}
C. dactylon	78.51±0.52^{a}	5.30±0.76^{b}	76.10±0.12^{a}	42.50±0.43^{a}	6.50±0.19^{b}	37.60±0.16^{b}
B. insulpta	88.11±0.73^{a}	3.32±0.37^{c}	67.30±0.89^{a}	49.30±0.26^{a}	11.75±0.72^{a}	38.80±0.57^{b}
C. virgata	91.79±0.128^{a}	4.23±0.372^{b}	74.10±0.782^{a}	42.90±0.53^{a}	9.25±0.67^{a}	53.40±0.11^{a}

Key: ^{ab}means±SE with different superscripts along the same column are significantly different (p<0.05).

Table V. *Mineral composition of locally available grasses collected in August 1999.* (Composición mineral de las gramíneas locales disponibles en agosto de 1999).

Samples	Major minerals (g/kg)					Minor minerals (mg/kg)			
	Ca	P	K	Na	Mg	Cu	Fe	Mn	Zn
P. maximum	6.64^{b}	0.82^{b}	11.42^{a}	0.33^{a}	0.63^{b}	2.00^{b}	106^{c}	1.00^{d}	76.39^{ab}
E. rigidor	2.04^{d}	1.08^{a}	4.96^{bc}	0.86^{a}	2.66^{a}	2.00^{b}	588^{a}	6.00^{c}	18.31^{bc}
E. scorperium	4.49^{c}	0.63^{b}	10.90^{b}	0.29^{a}	0.45^{b}	2.00^{b}	186^{c}	4.00^{c}	107.34^{a}
B. nigropedata	6.82^{b}	0.96^{b}	14.56^{a}	0.41^{a}	2.35^{a}	2.00^{b}	150^{c}	3.00^{d}	41.36^{b}
U. trichopus	5.00^{b}	1.18^{a}	8.35^{b}	1.23^{a}	0.78^{b}	2.00^{b}	92^{d}	2.00^{d}	148.16^{a}
D. melagiana	7.81^{b}	0.93^{b}	6.84^{bc}	0.27^{a}	0.99^{b}	2.00^{b}	301^{b}	4.00^{c}	7.22^{c}
B. maglothi	10.75^{a}	0.76^{b}	10.39^{b}	0.86^{a}	0.67^{b}	1.00^{b}	198^{c}	6.00^{c}	36.56^{b}
C. ciliaris	2.04^{d}	0.74^{b}	5.18^{bc}	0.23^{a}	0.89^{b}	2.00^{b}	578^{a}	3.00^{d}	15.90^{bc}
E. lehmaniana	3.05^{d}	0.89^{b}	2.33^{c}	0.19^{a}	0.91^{b}	1.00^{b}	406^{b}	BDL	18.30^{bc}
E. superba	2.68^{d}	0.89^{b}	5.25^{bc}	0.27^{a}	0.98^{b}	1.00^{b}	598^{a}	1.00^{d}	55.23^{b}
R. repens	4.43^{c}	0.68^{b}	11.42^{a}	0.38^{a}	0.44^{b}	1.00^{b}	87^{d}	4.00^{c}	38.90^{b}
A. congesta	4.43^{c}	1.17^{a}	2.22^{c}	0.21^{a}	2.34^{a}	3.00^{b}	468^{b}	9.00^{b}	2.72^{c}
H. contortus	3.39^{c}	1.20^{a}	3.53^{c}	0.20^{a}	1.25^{a}	2.00^{b}	79^{d}	2.00^{d}	3.49^{c}
C. dactylon	3.72^{c}	1.32^{a}	7.35^{bc}	0.96^{a}	1.19^{a}	2.00^{b}	498^{b}	4.00^{c}	112.15^{a}
B. insulpta	4.57^{c}	1.61^{a}	4.39^{c}	0.21^{a}	1.76^{a}	2.00^{b}	157^{c}	5.00^{c}	118.73^{bc}
C. virgata	8.45^{a}	1.12^{a}	10.90^{b}	0.39^{a}	1.40^{a}	8.00^{a}	124^{c}	28.00^{a}	81.02^{ab}

Key: ^{abcd} means with different superscripts along the same column are significantly different.

Both Ca (from 6.75 g/kg for *U. trichopus* to 1.62 for *E. lehmaniana)* and K(from 1.35 g/kg for *A. congesta* to 5.37 for *C. ciliaris)* were the highest for the October samples **(table VII)**. P is generally low in all the grasses as compared to June and August samples. Na (from 0.087 g/kg for *E. lehmaniana* to 3.30 for *E. scorperium)* and Mg (0.26-2.18 g/kg) were fairly low. The Fe (from 264 mg/kg for *U. trichopus* to 669 for *D. melagiana)* and Mn (from 28 mg/kg for *E. lehmaniana* to 233 for *D. melagiana)* contents are higher than Cu or Zn. The Zn is fairly high, *U. trichopus* being the highest with 93mg/kg and *A. congesta* being the lowest with 12.0. Cu is the lowest (3-6 mg/kg) of all minor minerals.

The lower value for DM content in December **(table VIII)** is 39.35 percent for *U. trichopus.* DM contents are lower than August and October but higher than June. The CP (from 0.93 percent for *C. excavatus* to 4.58 for *C. dactylon)* with less significance between the species. The NDF (61-79 percent) shows no significant difference between species.The ADF ranges from 36.40 percent for *C. dactylon* to 55.60 for *C. exacavatus.* The ash content averages at 11.34 percent and ranges from 5.38 percent to 14.83 percent. The IVTD (38.80-53.20 percent) have no significance between the species. It is lower than June and October samples but higher than August.

In December, Ca (from 1.11 g/kg for *H. contortus* to 6.41 g/kg for *S. pappophroides)* and K (from 0.34 g/kg for *E. superba* to 7.09 g/kg for *T. racemosus)* are higher than other major minerals **(table IX)** with significance between grasses. Mg (0.09-1.35 g/kg) is fairly high and Na (0.02-0.55 g/kg). P is lower in all grasses, with no significance between the species. Fe (118mg/kg in *A. congesta* and 532 in *C. excavatus)* seems to be the highest of minor minerals, it is followed by Mn, *(from S. pappaphroides* with 25 mg/kg to *C. dactylon* with 83). Zn is fairly high with differences between grasses and Cu is lowest.

DISCUSSION

The nutritive value varied for different grass species, being affected by different factors like seasonal fluctuations, stage of growth, soil fertility, leaf-stem ratio and toxic substances. The data in **table II** clearly indicated that there were differences in the chemical composition of the fifteen local grass samples. The DM range agreed with the findings by Gupta *et al*. (1987) who found that the dry matter mean value of tropical grasses was 61.35 percent in wet season. From the results *C. ciliaris* had the lowest DM content and high CP, while *H. contortus*, showed the highest DM but lowest CP content. This could be due to the fact that *C. ciliaris* was sampled when it was at an early stage of growth and *H. contortus* at its latest stage of maturity. Also the higher CP content of *C. ciliaris* could be due to its higher leaf to stem ratio

There is no significant difference in the NDF content between the species,

Table VI. *Nutrient composition (percent) of locally available grasses collected in October 1999.* (Composición nutritiva (p.100) de las gramíneas locales disponibles en agosto de 1999).

Samples	DM	CP	NDF	ADF	ASH	IVTD
E. rigidor	86.32±0.13^{ab}	2.13±0.10^{a}	74.30±0.86^{a}	46.8±0.42^{b}	7.25±1.27^{b}	39.20±0.21^{b}
E. scorperium	93.75±0.71^{a}	1.77±0.12^{a}	78.40±0.63^{a}	51.0±0.42^{a}	5.00±0.19^{c}	50.40±0.67^{a}
U. trichopus	69.15±0.51^{b}	2.64±0.62^{a}	77.50±0.55^{a}	46.8±0.93^{b}	11.75±1.16^{a}	55.20±0.91^{a}
D. melagiana	84.10±0.44^{ab}	2.94±0.57^{a}	70.70±0.57^{a}	44.6±1.34^{b}	10.50±0.37^{a}	63.20±0.27^{a}
C. ciliaris	63.25±1.57^{b}	1.39±0.25^{a}	77.40±0.43^{a}	52.1±0.47^{a}	5.50±0.44^{c}	44.41±0.15^{b}
E. lehmaniana	83.92±0.43^{ab}	1.31±0.29^{a}	76.90±0.62^{a}	50.9±0.11^{a}	6.00±0.51^{c}	50.80±0.77^{a}
E. superba	42.65±0.52^{c}	2.67±0.02^{a}	71.40±0.39^{a}	39.9±0.47^{b}	8.00±0.51^{b}	65.40±0.53^{a}
A. congesta	90.60±0.69^{a}	1.12±0.51^{a}	74.20±0.56^{a}	50.4±0.12^{a}	7.50±0.52^{b}	54.60±0.27^{a}
C. dactylon	84.38±0.80^{ab}	2.53±0.19^{a}	70.40±0.84^{a}	43.1±0.63^{b}	6.25±0.25^{c}	56.40±0.13^{a}
B. insulpta	89.27±0.74^{ab}	1.69±0.39^{a}	69.10±0.51^{a}	46.2±0.41^{b}	8.00±0.51^{b}	57.43±0.46^{a}
C. virgata	50.16±0.52^{c}	2.15±0.12^{a}	74.80±0.98^{a}	46.7±0.34^{b}	12.75±0.13^{a}	56.41±0.70^{a}
S. pappophroides	93.83±0.77^{a}	1.94±0.57^{a}	77.80±0.10^{a}	51.9±0.18^{a}	5.25±0.28^{c}	47.60±0.51^{b}

Key: ^{abc} means±SE with different superscripts along the same column are significantly different at p<0.05.

it is ranging from 64.20 for *C. ciliaris* to 76.40 for *E. superba. C. ciliaris* might have been sampled at an earlier stage of maturity, thus it has the lowest NDF content. NDF consists of cellulose, hemicellulose and lignin, thus when the grass is at earlier stage of growth or younger, it contains less cell wall contents, which increases with advancing maturity. The ADF showed the same trend as NDF. ADF consists of cellulose and lignin which also increase with maturity. This is in line with the findings of Bo Gohl (1981) who reported an increase in NDF, ADF and lignin content when grasses mature. This can also be explained by the fact that leaf fraction contains less cell wall contents as compared to stem fraction and by having knowledge that *C. ciliaris* is a leafy grass, this might be the case. There is no significant difference between ADF values.

The *in vitro* true digestibility is ranging from 43.4 percent for *C. dactylon* and to 60.4 for *B. insulpta,* with differences between the species, as recorded by Field (1976) who found that the digestibility of native grasses collected in Botswana ranges from 43.90 to 60.00 percent. *C. dactylon* contains fairly high CP (8.05 percent) but it has the lowest value of digestibility, this could have resulted because of *C. dactylon* has higher NDF content and may be that the neutral detergent fibre contains large amounts of lignin which lowered the digestibility of this grass. Since lignin is indigestible, large amounts of it mask cellulose and hemicellulose and lowers their digestibility. There is an inverse relationship between digestibility and lignin content, thus the higher the lignin

***Table VII**. Mineral composition of locally available grasses collected in October 1999.* (Composición mineral de las gramíneas locales disponibles en octubre de 1999).

	Major minerals (g/kg)				Minor minerals (mg/kg)				
Samples	Ca	P	K	Na	Mg	Cu	Fe	Mn	Zn
E. rigidor	2.07^{b}	0.22^{a}	2.94^{a}	0.073^{a}	0.57^{a}	4.00^{a}	319^{b}	53.00^{b}	19.40^{c}
E. scorperium	2.54^{b}	0.03^{a}	3.06^{a}	3.30^{a}	2.18^{a}	4.00^{a}	388^{b}	35.00^{c}	50.60^{b}
U. trichopus	6.75^{a}	0.25^{a}	3.46^{a}	0.16^{a}	0.68^{a}	5.00^{a}	264^{c}	61.00^{ab}	93.00^{a}
D. melagiana	4.60^{a}	0.09^{a}	4.80^{a}	0.18^{a}	0.94^{a}	6.00^{a}	669^{a}	233.00^{a}	41.60^{b}
C. ciliaris	2.54^{b}	0.11^{a}	5.38^{a}	0.10^{a}	0.83^{a}	4.00^{a}	294^{c}	35.00^{c}	13.20^{d}
E. lehmaniana	1.62^{b}	0.21^{a}	1.68^{a}	0.08^{a}	0.97^{a}	3.00^{a}	276^{c}	28.00^{c}	17.20^{c}
E. superba	4.94^{a}	0.28^{a}	4.48^{a}	0.13^{a}	0.72^{a}	4.00^{a}	108^{c}	50.00^{b}	26.80^{b}
A. congesta	2.01^{b}	0.17^{a}	1.35^{a}	0.03^{a}	0.26^{a}	3.00^{a}	360^{b}	43.00^{c}	12.00^{d}
C. dactylon	3.77^{a}	0.29^{a}	2.97^{a}	0.17^{a}	0.51^{a}	4.00^{a}	598^{a}	45.00^{b}	50.00^{b}
B. insulpta	4.48^{a}	0.64^{a}	3.48^{a}	0.19^{a}	1.40^{a}	3.00^{a}	391^{b}	37.00^{c}	37.80^{b}
C. virgata	4.11	0.04^{a}	2.58^{a}	0.13^{a}	0.44^{a}	4.00^{a}	569^{a}	58.00^{ab}	22.00^{c}
S. pappophroides	1.75^{b}	0.53^{a}	2.58^{a}	0.09^{a}	0.56^{a}	3.00^{a}	519^{a}	61.00^{ab}	37.40^{b}

Key: ^{abc} means with different superscripts along the same column are significantly different at p<0.05.

content, the lower the digestibility.

The data in **table III** illustrates, the mineral composition varies in different grass species. Generally the amount of mineral content in grass depend on the nutrient status of soil and the rate of absorption of the minerals, so this will depend on the structure of the root system of the grass. The grasses seems to have high content of K (from 4.81 to 42.29 g/kg), this could be due to high soil contents of K. The lower content discovered in *H. contortus* could have resulted due to poorly structured root system. The Na concentration of grasses could have been affected by their genetic make-up, thus, Na content is low for all the grasses, this can also result propably because Botswana soils have low levels of Na (Aganga *et al.*, 1994). The Na concentration of grasses is mainly associated with genetic factors (Stobbs, 1973).The Ca and Mg are fairly high but Mg is lower than Ca in all the grasses, this is good because Mg is associated with utilization of Ca. Also the minor minerals depend on the nutrient status of the soil.

Table IV shows the nutrient composition of native grasses collected in August. On average the dry matter content of the August is higher than that of the June samples. There is no significant difference between species. On average the CP has reduced as compared to 8.36 percent for June samples, thus it is half the June mean value. Crude protein is higher when it is not dry and lower when it's dry. The NDF ranges from 66.50 to 83.10

Table VIII. *Nutritive content (percent) of locally available grasses collected in December 1999.* (Composición nutritiva (p.100) de las gramíneas locales disponibles en diciembre de 1999).

Samples	DM	CP	NDF	ADF	ASH	IVTD
P. maximum	58.20±0.26^{ab}	2.81±0.43^{b}	73.00±1.37^{a}	47.90±0.29^{a}	9.18±0.57^{a}	49.20±0.23^{a}
E. rigidor	68.88±0.70^{ab}	2.21±0.36^{b}	71.00±0.11^{a}	43.80±0.67^{a}	5.38±0.78^{a}	38.80±0.16^{a}
E. scorperium	52.99±0.45^{ab}	3.19±0.66^{a}	70.00±0.25^{a}	47.23±0.16^{a}	7.88±0.86^{a}	50.70±0.47^{a}
U. trichopus	39.35±0.17^{b}	4.37±0.52^{a}	66.00±0.37^{a}	44.10±0.19^{a}	14.83±0.67^{a}	45.70±0.29^{a}
C. ciliaris	58.91±0.84^{ab}	2.59±0.42^{b}	70.00±0.84^{a}	44.00±0.46^{a}	7.30±0.84^{a}	45.62±0.31^{a}
E. lehmaniana	73.35±0.18^{a}	2.45±0.19^{b}	74.00±0.39^{a}	49.82±0.29^{a}	7.55±0.30^{a}	49.00±0.66^{a}
E. superba	52.75±0.70^{ab}	2.56±0.71^{b}	76.00±0.13^{a}	42.50±0.95^{a}	6.58±0.71^{a}	53.20±0.27^{a}
R. repens	58.33±0.97^{ab}	1.717±0.10^{b}	79.00±0.48^{a}	46.40±0.72^{a}	7.08±0.05^{a}	41.64±0.23^{a}
A. congesta	79.32±0.31^{a}	2.26±1.25^{b}	78.00±0.97^{a}	46.50±0.10^{a}	6.23±0.87^{a}	51.90±0.71^{a}
H. contortus	85.69±0.76^{a}	1.28±0.85^{b}	77.00±0.64^{a}	52.00±0.91^{a}	5.88±0.14^{a}	42.50±0.62^{a}
C. dactylon	49.26±0.52^{b}	4.58±0.11^{a}	73.00±0.17^{a}	36.40±0.29^{a}	7.20±0.39^{a}	51.60±0.13^{a}
B. insulpta	59.56±0.58^{ab}	2.32±1.22^{b}	74.00±0.73^{a}	45.51±0.32^{a}	8.05±0.50^{a}	50.20±0.79^{a}
S. pappophroides	64.15±0.50^{ab}	1.91±0.66^{b}	74.00±0.43^{a}	46.14±0.42^{a}	6.13±0.23^{a}	48.30±0.65^{a}
C. racemosus	94.67±0.31^{a}	2.83±0.91^{b}	68.00±0.31^{a}	43.60±0.48^{a}	9.60±0.55^{a}	49.30±0.82^{a}
C. excavatus	89.66±0.33^{a}	0.927±0.05^{b}	76.00±0.58^{a}	55.60±0.52^{a}	7.93±0.42^{a}	47.50±.94^{a}
E. cenchroides	94.74±0.52^{a}	4.14±0.41^{a}	61.00±0.62^{a}	38.54±0.78^{a}	10.70±0.97^{a}	50.20±0.80^{a}

Key: ^{ab}mean±SE with different superscripts along the same column are significantly different at p<0.05.

percent.The NDF as well as the ADF averages have increased as compared to that of June, thus the NDF increased from 72.61 to 75.27 percent. NDF in August are higher than June, as reported by Frame (1991) who found that the NDF in grasses grown in dry were higher than that in summer. This indicates that grasses grown in dry season mature at an early stage and may have higher fibre components.

The *in vitro* digestibility (average 41.54 percent) has decreased as compared to 50.77 percent for June samples. The higher digestibility observed in June may be explained by the presence of more young vegetation and higher proportion of leaves which are known to contain higher protein content in grasses. The low *in vitro* digestibility in August may be due to early maturation of grasses which led to higher fibre and lignin contents. The ash content on average increased from 9.94 to 11.17 percent. As shown in **table V** the same trend is observed as in **table III**, thus the K is the highest and Na is the lowest of all the major minerals. On average Ca content decreased. This could be due to that the percentage of calcium in leaf fraction is twice that in stem and thus the grasses have high proportion of stem when they are dry. The Cu content on average is reduced.

In October **(table VI)** the DM is significantly different between species. The dry matter is averaging at 76.46 percent, lesser than that of August but higher than 61.26 percent of June samples. The variable trend of DM between the August and October samples may have resulted from differences in physical, chemical and biological properties of the grass species. The CP averages 2.11 percent with no significant difference between the species and is lesser than that of August and also June. As stated before, in October it was dry, just like in August, the nutrient absorption was hampered due to high moisture stress. The NDF is averaging at 74.09 as compared to 75.27 percent for August. The ADF is also reduced and the *in vitro* digestibility is ranging from 39.20 for *E. superba* to 65.40 for *D. melagiana* with an average of 49.14 percent. The Ca and K are higher than other major minerals as shown in **table VI**, thus may be the soils where sampling was done contained higher content of them. P is the lowest of them all. Also the level of P in grasses depend on the stage of growth, thus it is decreased as the grass mature.

The dry matter in December**(table VIII)** averages 64.73 percent lower tha August and October but higher than June. There is significant difference between species. The CP (average of 2.62 percent) and less significance between grass species. The NDF averages at 73.00 percent with no significance between grass species at $p<0.05$. It is lower than that of October samples. There was very little rain observed early December, but heavy rains started late December. So the variable DM, CP and NDF contents might be due to the fact that some grasses were rejuvenating and thus lead to decrease in DM and increase in CP. The*in vitro* digestibility averages at 44.09 percent with no significance between species. It is lower as compared to 49.14 percent for October. This could be due to

species which were lignified. As shown in **table IX**, also in **table VII**, thus calcium and potassium as being the highest of all major minerals and phosphorus being the lowest.

Generally the DM means and CP means between the months are different ($p<0.05$). There is no significant difference in the NDF, ADF, IVTD and ash means between the months. For the major minerals, Ca and Na means are not significantly different between months. There is significance in the P, K and Mg means between the months. The protein contents in the grasses were generally low compared to the requirements of grazing ruminants therefore, the animals need to be supplemented on legume hays for them to meet their CP requirements. Also , it is important for the grazing animals to be supplemented with dicalcium phosphate for the animals to meet their Ca and P requirements especially to maintain the 2:1 Ca:P ratio for optimal metabolism in the animal body.

In conclusion, during the dry season the dry matter and fibre content (NDF and ADF) increased. The crude protein of the native grasses reduced during the dry season. Seasonal fluctuations affect the digestibility of the grasses, thus during the dry season the digestibility reduced.The mineral content of the grasses especially calcium, potassium and magnesium is reduced during the dry season.

Table IX. *Mineral composition of locally available grasses collected in December 1999.* (Composición mineral de las gramíneas locales disponibles en diciembre de 1999).

	Major minerals (g/kg)					Minor minerals (mg/kg)			
Samples	Ca	P	K	Na	Mg	Cu	Fe	Mn	Zn
P. maximum	2.29^{a}	0.07^{a}	2.00^{b}	0.15^{a}	0.65^{a}	4.00^{b}	367^{b}	40.0^{b}	30.60^{c}
E. rigidor	4.71^{a}	0.04^{a}	4.58^{a}	0.03^{a}	0.34^{a}	2.00^{b}	520^{a}	31.0^{b}	10.80^{d}
E. scorperium	1.72^{b}	0.02^{a}	3.01^{b}	0.07^{a}	0.68^{a}	3.00^{b}	360^{b}	34.0^{b}	86.80^{a}
U. trichopus	2.31^{a}	0.09^{a}	3.01^{b}	0.55^{a}	0.69^{a}	4.00^{b}	177^{c}	63.0^{a}	42.20^{c}
C. ciliaris	2.83^{a}	0.03^{a}	5.89^{a}	0.12^{a}	0.75^{a}	3.00^{b}	354^{b}	27.0^{b}	10.40^{d}
E. lehmaniana	3.83^{a}	0.05^{a}	2.66^{b}	0.07^{a}	0.48^{a}	2.00^{b}	362^{b}	26.0^{b}	9.40^{d}
E. superba	2.05^{b}	0.05^{a}	0.34^{b}	0.11^{a}	1.13^{a}	3.00^{b}	411^{a}	44.0^{b}	12.40^{d}
R. repens	3.01^{a}	0.08^{a}	5.86^{a}	0.08^{a}	1.07^{a}	2.00^{b}	366^{b}	37.0^{b}	13.60^{d}
A. congesta	1.60^{b}	0.04^{a}	5.00^{a}	0.19^{a}	0.71^{a}	2.00^{b}	118^{c}	31.0^{b}	7.40^{d}
H. contortus	1.11^{b}	0.05^{a}	2.40^{b}	0.48^{a}	0.56^{a}	2.00^{b}	479^{a}	81.0^{a}	24.00^{c}
C. dactylon	6.00^{a}	0.04^{a}	4.53^{a}	0.19^{a}	1.18^{a}	8.00^{a}	322^{b}	83.0^{a}	53.80^{b}
B. insulpta	2.27^{a}	0.04^{a}	2.50^{b}	0.11^{a}	0.78^{a}	3.00^{b}	395^{b}	73.0^{a}	30.20^{c}
S. pappophroides	6.41^{a}	0.07^{a}	2.81^{b}	0.23^{a}	0.30^{a}	3.00^{b}	460^{a}	25.0^{b}	16.80
C. excavatus	2.46^{a}	0.10^{a}	1.67^{b}	0.03^{a}	0.09^{a}	2.00^{b}	532^{a}	51.0^{a}	28.80^{c}
T. racemosus	1.65^{b}	0.03^{a}	7.09^{a}	0.51^{a}	1.35^{a}	3.00^{b}	362^{b}	42.0^{b}	57.80^{b}
E. cenchroides	6.05^{a}	0.06^{a}	3.51^{a}	0.24^{a}	0.88^{a}	8.00^{a}	424^{a}	32.0^{b}	41.00^{b}

Key: ^{abcd} means with different superscripts along the same column are significantly different at $p<0.05$.

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