Comparison of digestibility and metabolizable energy between nilegrass and pangola grass

Jeng-Bin Lin[2], Mei-Chu Lee[3], Shyh-Rong Chang [4] and F.H. Hsu[5]

[1]Contribution paper no.1228 from Livestock Research Institute, Council of Agriculture, Executive Yuan, Taiwan.

[2] Livestock Research Institute, Council of Agriculture, Executive Yuan, Taiwan, www.tlri.gov.tw Email jblin@mail.tlri.gov.tw
[3] Diwan College of Management, Taiwan, www.dwu.edu.tw Email mclee@mail.dwu.edu.tw
[4] Livestock Research Institute, Council of Agriculture, Executive Yuan, Taiwan, www.tlri.gov.tw Email srchang@mail.tlri.gov.tw
[5] Livestock Research Institute, Council of Agriculture, Executive Yuan, Taiwan, www.tlri.gov.tw Email Fhhsu@mail.tlri.gov.tw

Abstract

Nilegrass (*Acrocras macrum* Stapf) and pangola grass（*Digitaria decumbens* Stent）are perennial C3 and C4 forage grasses, respectively, that produce high forage yield and quality in Taiwan. The objectives of this study were to measure aspects of the quality (metabolizable energy [ME], acid detergent fibre [ADF], neutral detergent fibre [NDF], crude protein [CP]), and observe changes in cell wall digestion, of nilegrass and pangola grass sampled after 4, 6, 8 and 10 weeks of regrowth in spring and fall crops. The contents of ADF and NDF of nilegrass were lower than those of pangola grass in both spring and fall crops. The 4-week crude protein content of both nilegrass and pangola grass were higher than those of the 6, 8 and 10-week growth stages. The ME content of the 6 and 8-week cuts of nilegrass were higher than those of 4 and 10-week cuts in both seasons. After 72 hours in the rumen, both stem and leaf of nilegrass up to 8 weeks growth stage had been digested by rumen micro organisms. For comparable samples of pangola grass the leaf had been digested while the stem tissue was mostly undegraded. The results showed that nilegrass has a higher quality and is more easily digested than pangola grass when grown under the same conditions and is a potential replacement for pangola grass in Taiwan.

Media summary

Both nilegrass and pangolagrass had the highest metabolizable energy at 6 week growth stage. Nilegrass was more easily digested and had better forage quality than pangola grass.

Key words

Nilegrass (*Acrocras macrum* Stapf), Pangola grass（*Digitaria decumbens* Stent), digestibility, anatomy.

Introduction

Nilegrass (*Acroceras macrum* Stapf) is a perennial C3 forage grass (Oliveira *et al*., 1973) and has been proposed by Shaug *et al*., (1999) as an alternative to pangola grass (*Digitaria decumbens*) for Taiwan. A study to compare the growth and forage quality of these grasses has been reported by Hsu *et al.* (2004). Plant samples from that study were used to develop a more comprehensive understanding of the morphological characteristics and quality attributes of these grasses.

Methods

Chemical contents and metabolizable energy: The contents of metabolizable energy (ME), ether extract (EE) , nitrogen-free extract (NFE), 24hr gas production (Gb24), crude protein (CP), acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined following the methods presented by Close and Menke (1986) and Olsen and Dean (1965) for oven-dried samples of Nilegrass cv. Taishi No. 1 and pangola grass line A254. Samples were taken from cuts at 4, 6, 8 and 10 week intervals in fall (October) and spring (April) in the second year of the experiment, with four replicates per grass per cutting interval.

Digestibility: Fresh samples of Nilegrass and pangola grass cut at 4, 6, 8 and 10 week intervals were collected at the spring (April) harvest. Fresh samples were enclosed in nylon bags (20 micron mesh) and suspended in the rumen of a cannulated dairy cow. The bags were removed from the rumen after 24, 48 and 72 hours for observation of changes in plant anatomy. Sections were obtained using the paraffin-cut technique reported by Lin and Yeh (1996).

Results

Chemical contents and metabolizable energy: The contents of ADF and NDF in nilegrass were lower than those of pangola grass in both spring and fall crops (Table 1). For both grasses and in both seasons, the highest ME was achieved at the 6 and 8 week growth stages (Table 2, 3).

Effects of different growth stages on digestibility of nilegrass and pangola grass

After 72 hours in the rumen, both stem and leaf of nilegrass had been mostly digested for the 4, 6 and 8 week cuts, while only the leaves of pangola grass cut at 4 and 6 weeks were easily digested (Fig. 1 A, B, C and D). Both stem and leaf of pangola grass cut at 8 and 10 weeks were not easily digested (Fig.1 F and H). The anatomical observations of plant tissues digested by rumen microorganisms, showed that most of the cell wall structure of nilegrass was degraded 72 hours after digesting in rumen of dairy cow. However, the cell wall of pangola grass was not completely degraded during the same period (Fig. 1).

Conclusion

In almost every measure of *in vitro* quality nilegrass was superior to pangola grass. The complete rumen digestion of both leaf and stem for samples of nilegrass cut up to 8-week intervals was in shape contrast to that for pangola grass.

References

Bourquin, LD and Fahey GC (1994). Ruminal digestion and glycosyl linkage patterns of cell wall components from leaf and stem fractions of alfalfa, orchard -grass, and wheat straw. J. Anim. Sci.72, 1362-1374.

Cassab GI and Varner JE (1987). Immunocy tolocalization of extensin in developing soybean seed coats by immunopgold-silver staining and by tissue priting on nitrocellulose paper. J. Cell Biol. 105, 2581-2588.

Close W and Menke KH (1986). Selected topics in animal nutrition, pp. 26-66. 2nd Edition, Animal Nutrition. University of Huhenelm, Germany.

Grabber JH, Jung GA and Hill RR (1991). Chemical composition of parenchyma and sclerenchyma cell walls Isolated from orchardgrass and switchgrass. Crop. Sci. 31, 1058-1065.

Jung HG. and Deetz DA (1993). Cell wall lignification and degradability, pp. 315-346. *In* Jung, H. G., Buxton, D. R., Hatfield, R. D., Ralph, J. (ed) Forage cell wall structure and digestibility. ASA, Inc., SSSA, Inc., Madison, Wisconsin, USA.

Lee CF, Chen CP and Shiao TF (1999). Feeding values of pangolagrass and bermudagrass hay for lactating dairy cows. Taiwan Livestock Res.32, 353-364.

Lin JB and Yeh MS (1996). Development of embryo and endosperm derived from selfing and interspecific hybridization between *Glycine max* x *G.. tomentella*. J. Agric. Associ. China 173, 17-27.

Oliveira BAD, Faria PR, Souto SM, Carneiro AM, Dobereiner J and Aronovich S (1973) Identification of tropical grasses with the C4 pathway of photosynthesis from leaf anatomy. Pesquisa Agrope Cuaria Brasileira, Agronomia 8, 267-271.

Olsen SR and Dean LA (1965). Phosphorus, pp. 1035-1048. *In* Black, “C. A. (ed) Method of soil analysis” part 2. American Society of Agronomy Inc., Madison, Wisconsin.

Shaug SP, Lo KD and Lin JB (1999). Effects of cutting stages on forage yield and quality of nilegrass. Taiwan Livestock Res. 32, 219-226.

Smith LW, Goering HK and Gordon CH (1972). Relationships of forage compositions with rates of cell wall digestion and undigestibitity of cell walls. J. Dairy Sci. 55, 1140-1147.

Wilson JR (1993) Organization of forage plant tissues, pp.1-27. *In.* Jung, H. G., Buxton, D. R., Hatfield, R. D., Ralph, J. (ed) Forage cell wall structure and digestibility. ASA, Inc., SSSA, Inc., Madison, Wisconsin, USA.

Table 1. Comparision of the chemical contents between nilegrass and pangola grass at different growth stages in spring and fall crops (%).

Growth stage week		Spring			Fall		
	Species	CP	ADF	NDF	CP	ADF	NDF
4	Nilegrass	12.35^{a*}	35.14^{b}	59.23^{b}	11.96^{a*}	34.41^{b}	61.12^{b}
	Pangolagrass	10.48^{a}	39.67^{a}	63.09^{a}	9.39^{b}	39.08^{a}	70.89^{a}
6	Nilegrass	10.58^{a}	36.29^{b}	59.81^{b}	9.33^{a}	35.94^{b}	66.76^{b}
	Pangolagrass	9.88^{a}	39.09^{a}	59.83^{b}	7.26^{b}	38.47^{a}	69.96^{a}
8	Nilegrass	6.76^{a}	37.09^{b}	56.72^{b}	8.67^{a}	36.72^{b}	68.96^{b}
	Pangolagrass	6.64^{a}	39.48^{a}	68.13^{a}	5.92^{b}	41.50^{a}	73.46^{a}
10	Nilegrass	5.20^{a}	38.04^{b}	59.31^{b}	7.15^{a}	38.13^{b}	69.08^{b}
	Pangolagrass	5.15^{a}	39.22^{a}	64.99^{a}	5.68^{a}	42.13^{a}	72.82^{a}

*Means within columns and at the same growth stage with the same letter are not significantly different ($P<0.05$).

Table 2. Effects of different growth stages on the chemical contents and metabolizable energy of nilegrass and pangola grass in spring crop.

Growth stage	Nilegrass	Pangolagrass

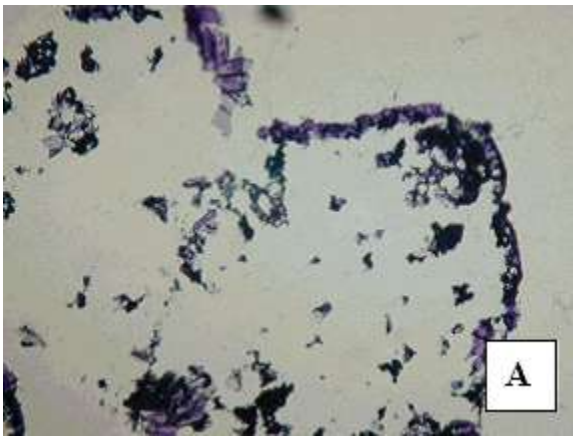
	EE[@]	NFE	Gb24	ME	EE	NFE	Gb24	ME
week	%	%	My/200mg	Mcal/Kg	%	%	My/200mg	Mcal/Kg
4	2.53[c*]	61.5[a]	40.3[a]	9.79[c]	2.18[a]	64.7[b]	40.1[a]	8.97[c]
6	1.56[b]	59.3[b]	42.2[b]	10.08[a]	1.98[b]	63.3[d]	40.4[ab]	9.96[a]
8	1.77[a]	62.0[a]	41.4[ab]	9.92[b]	1.41[c]	65.7[b]	41.7[b]	9.20[b]
10	1.83[a]	65.9[c]	41.0[ab]	9.71[d]	1.42[c]	66.5[a]	39.6[a]	9.00[c]
SEM	0.036	0.422	0.570	0.017	0.027	0.410	0.530	0.020

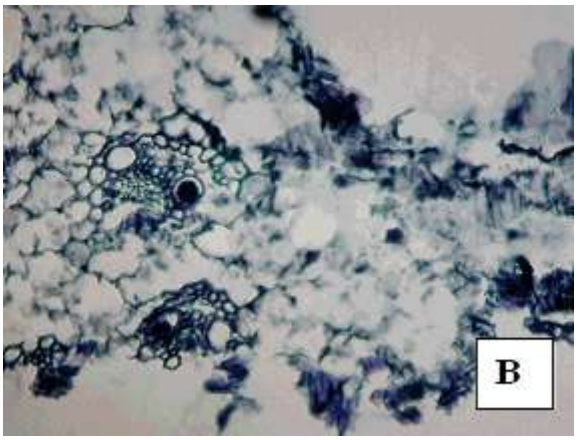
*Means with the same letter in the same column are not significantly different (P<0.05).

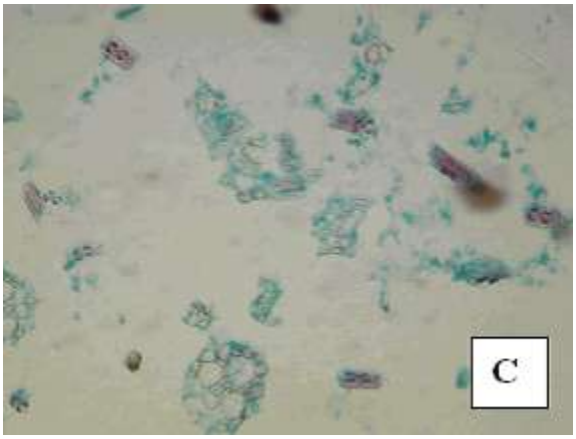
Table 3. Effects of different growth stages on the chemical contents and metabolizable energy of nilegrass and pangola grass in fall crop.

Growth stage	Nilegrass				Pangolagrass			
	EE[@]	NFE	Gb24	ME	EE	NFE	Gb24	ME
week	%	%	My/200mg	Mcal/Kg	%	%	My/200mg	Mcal/Kg
4	1.42[a*]	63.2[c]	42.8[a]	9.95[c]	1.99[a]	61.9[a]	38.3[a]	8.01[c]
6	1.57[b]	65.6[b]	49.5[b]	10.97[a]	2.06 [b]	62.1[a]	44.3[b]	9.01[b]
8	1.61[b]	63.3[c]	45.5[c]	10.22[b]	2.17[c]	67.6[b]	42.8[b]	9.59[a]
10	1.18[c]	70.0[a]	42.7[a]	9.61[d]	2.10 [d]	67.3[b]	36.5[c]	8.33[d]
SEM	0.021	0.400	0.516	0.021	0.012	0.379	0.521	0.019

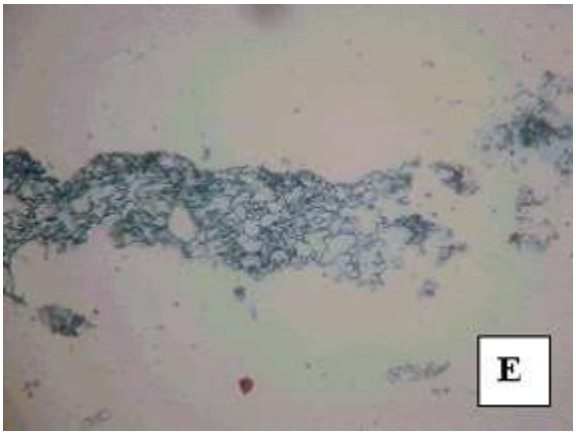
*Means with the same letter in the same column are not significantly different (P<0.05).

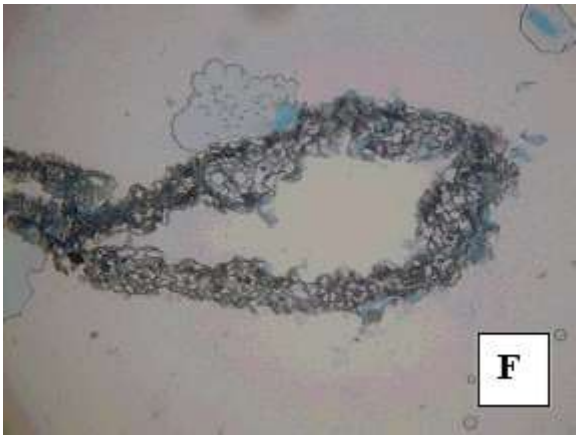

A


B


C


D


E


F

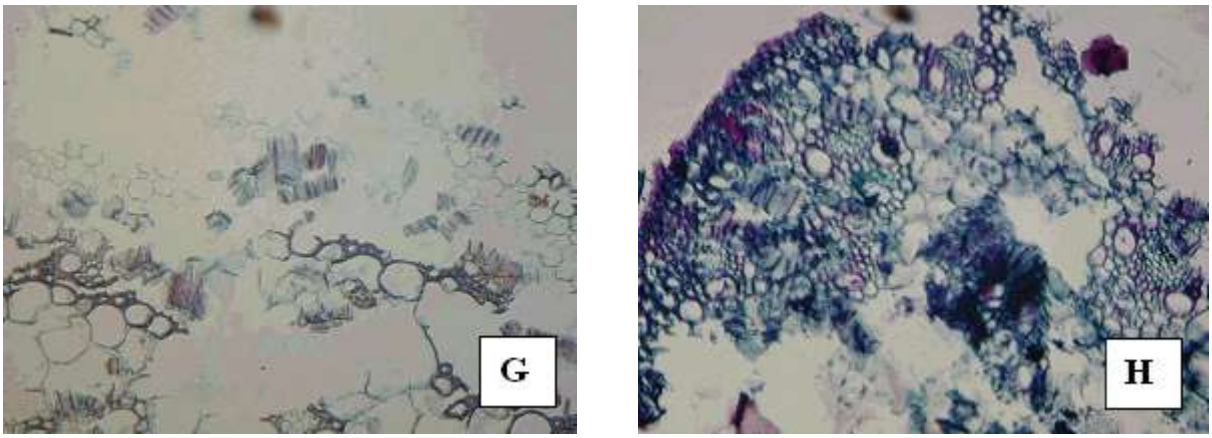


Figure 1. The cell walls of nilegrass (left) and pangola grass (right) internodes at 4 (A, B), 6 (C, D), 8（E, F) and 10 (G, H) weeks after cutting digested by rumen micro-organisms in the rumen for 72 hours observed by transverse section, respectively. (x 100).