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Nutritional evaluation of elephant grass hybrids

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Abstract

The nutritive value with regard to stage of maturity of elephant grass *(Pennisetum purpureum)* hybrids is largely unknown. Elephant grass (KW_4) and its hybrids namely, ILCA16786, ILCA16837, ILCA16791 and ILCA16798 were evaluated to determine the effect of stage of maturity on dry matter yields (DM), chemical composition, intake and digestibility by sheep. In the first experiment, forages were harvested at 6, 7, 8, 9,10, 11 and 12 weeks of re-growth. With advancing maturity, DM yields and the fibrous fractions increased while crude protein (CP) and *in vitro* DM digestibility (IVDMD) decreased. In the second experiment, the re-growths at 6 weeks were fed to sheep in form of hay. Apart from ILCA16837, the rest of the forages had similar DM intakes ($P>0.05$). For ILCA16798 a higher ($P<0.05$) DM digestibility was observed compared to the other hybrids but ILCA16791, ILCA 16786 and KW_4 did not show any significant difference while ILCA16837 had the lowest ($P>0.01$) DM digestibility. Digestibility of CP was similar for KW_4, ILCA16791 and ILCA16837 but was significantly different ($P<0.05$) from ILCA16798 and ILCA16786. Hybrid ILCA 16791, had the highest NDF and ADF digestibilities followed by ILCA16786 and ILCA 16837 while KW_4 and ILCA 16798 had the lowest. The differences in DM intake and digestibilities might have been influenced by the genetic makeup of the individual hybrids.

Key words: Chemical composition, digestibility, dry matter, forages, sheep

Introduction

Inadequacy in both quantity and quality of feed resources available all-year-round is a major constraint to livestock production in smallholder crop-livestock farming systems in Uganda (Saamanya,1996). Improving year-round fodder availability matched with strategic supplementation should be a high priority. Most smallholder dairy farmers use elephant grass (*Pennisetum purpureum*) as the main basal diet (Saamanya,1996; Muinga *et al.*, 1993). However unimproved *P.purpureum* matures very fast and declines in nutritive value rapidly. There is therefore need to introduce elite elephant grass hybrids to stabilise the feed resource base. The objective of these studies was to investigate the effect of stage of maturity of elephant grass hybrids on dry matter (DM) yields, chemical composition and utilization by sheep.

Materials and methods

The experiments were conducted at Makerere University Agricultural Research Institute, Kabanyolo (MUARIK), situated 19 km north of Kampala (0° 28'N, 32° 27'E, 1205 m.a.s.l) in the sub-humid zone of Uganda. Soils in the area are Ferralsols with an average pH of 5.7 (Olsen and Moe, 1971). Temperatures range from 28.5 to 15.9°C and the mean annual rainfall is about 1300mm with a bimodal pattern peaking in April and November. Two separate experiments as detailed below were conducted.

Experiment 1

A plot of 0.4 ha was ploughed and disc harrowed to make a fine seedbed. Four elephant grass hybrids, namely ILCA 16786, ILCA 16798, ILCA 16791, ILCA16837 and the local *P.purpureum* (KW_4) were planted on 2.5x 5 m plots in a completely randomised block design with four replicates. The planting material was obtained from stocks already established at Kabanyolo. The forages were established by staking cuttings at spacing 0.9m between rows and 0.5 within rows. They were cut back four weeks after planting to leave a stubble height of 15cm from the ground. This was done to allow uniform growth and full coverage of the field. Data collection was done weekly from the sixth to the twelfth week of regrowth. Duplicate samples were harvested using a $1m^2$ quadrant. These were weighed, sub-sampled and dried in an air-drought oven at 60^0C to constant weight. They were then ground through a 1 mm screen and stored in plastic bottles. The samples were analysed for dry matter (DM) and crude protein (CP) following standard procedures described earlier (AOAC, 1990). The fibre fractions, neutral detergent and acid detergent fibre (NDF and ADF) were determined according to Goering and van Soest (1970) and *in vitro* DM digestibility (IVDMD) was determined using the modified two-stage Tilley and Terry (1963) method as described by Barnes (1969). The data were subjected to a two factor ANOVA using MSTAT-C programme on a computer and means were separated by Duncan's Multiple Range Test (Duncan, 1955).

Experiment 2

Five mature sheep, averaging 35 kg body weight, were used in a 5 x 5 Latin square design to determine the digestibility of the forages. The animals were individually caged and given access to water and a salt lick all the time. Ten days were allowed for the sheep to get used to the cages before the start of the trial. Each period consisted of 7 days of adjustment and 7 days of collection. Fresh forage at 6 weeks of maturity was cut and chopped into 5 cm pieces and dried under shade. Weighed quantities of the hay were given *ad libitum* to the animals in the mornings and afternoons. During the collection period, feed, refusals and faeces were collected prior to the morning feeding and kept in a refrigerator. At the end of the collection period, the samples were pooled and an aliquot sample was taken for DM determination and chemical analyses as described in experiment 1. Data analysis was done using a 5 x 5 Latin square ANOVA with MSTAT-C computer programme and means were separated by Duncan's Multiple Range Test (Duncan, 1955).

Results and discussion

Experiment 1

The mean DM yields of the forages are given in Table 1. For KW_4, ILCA16798, and ILCA 16786 similar ($P>0.05$) DM yields were observed and were higher ($P<0.05$) than those for ILCA 16791 and ILCA 16837. Hybrid ILCA 16837, had the lowest ($P<0.05$) DM yields. Dry matter yields increased ($P<0.05$) with advancing stage of maturity, which is in agreement with results reported by Ogwang (1974) and Vincent-Chandler *et al.* (1959). Tilley (1970) reported that the increase in DM yield as elephant grass matured was largely composed of stem, as was the case in this study. Dry matter yield depends on the amount and distribution of rainfall, soil fertility, ambient temperature and level of management. Yield of elephant grass can range from 2 to 19 tons DM $ha^{-1}yr^{-1}$ on poor unfertilized soils to 55 t DM $ha^{-1}yr^{-1}$ when fertilised and water supply is adequate (Williams, 1980). Hassan *et al.* (1983) reported an average annual yield of about 300 t ha^{-1} of fresh fodder, equivalent to 49.5 t DM containing 5.3 t of crude protein.

There was no significant ($P>0.05$) difference in CP content between the forages (Table 2). However, ILCA 16798 had the highest CP content while ILCA 16786 had the lowest. The mean CP content of

the forages dropped from 13.77% at 6 weeks to 7.25% at 12 weeks. The CP content of ILCA16786 was high up to the 10th week when it started falling below the critical level of 7% required for efficient rumen function (Van Soest, 1994). Similar results have been reported by Minson(1971) and Ogwang (1974). However, the results reported are rather high compared with those reported for elephant grass harvested at similar stages of maturity in El Salvador (Watkins and Van Severen, 1951), in Trinidad (Patterson, 1953). Differences in the fibre fractions (NDF and ADF) among the forages were significant ($P<0.05$). The local check, KW_4, had the lowest while hybrid ILCA16937, had the highest NDF and ADF contents. The fibre fractions increased steadily as the forages matured. Similar results have been reported for elephant grass (Ogwang, 1974) and other tropical grasses (Minson, 1971).There was no significant ($P>0.05$) difference in IVDMD values between KW_4 and ILCA 16798 while ILCA 16786 had lower ($P<.0.05$) values than the rest (Table 4). The IVDMD values for all the forages declined ($P<0.05$) with increasing maturity. Significant differences in the IVDMD values of grass species found in Uganda have been reported (Marshal *et al.*, 1969; Reid *et al.*, 1973).

Table 1. Mean dry matter yields (t ha^{-1}) of elephant grass and its hybrids with advancing stages of maturity.

Maturity stage (weeks)	Forages type					Mean
	KW_4	ILCA 16798	ILCA 16791	ILCA 16786	ILCA 16837	
6	24.5	12.9	15.0	12.9	7.7	14.6^{d}
7	18.4	21.3	9.6	22.0	11.5	16.6^{cd}
8	22.0	26.1	16.2	22.5	13.5	20.0^{b}
9	22.0	17.1	17.6	26.7	12.7	19.1^{bc}
10	23.8	24.5	24.9	29.7	25.0	25.6^{a}
11	21.3	31.9	25.2	24.3	13.2	23.2^{a}
12	31.0	33.3	26.3	19.8	16.2	25.3^{a}
Mean	23.3^{a}	23.9^{a}	19.2^{b}	22.5^{a}	14.2^{c}	

^{abcd} Means followed by the same superscript are not significantly different($P>0.05$).

Table 2. Mean CP% in the DM of elephant grass and its hybrids at different stages of maturity.

Maturity stage (weeks)	Forages type					Mean
	KW_4	ILCA 16798	ILCA 16791	ILCA 16786	ILCA 16837	
6	15.75	13.12	13.75	15.09	11.15	13.77^{a}
7	10.71	14.21	12.68	10.28	10.71	11.71^{abc}
8	9.84	11.15	11.13	8.96	6.49	9.51^{abcd}
9	7.65	10.71	10.93	8.31	8.96	9.31^{abcd}
10	7.00	10.71	9.18	7.70	8.75	8.66^{bcd}
11	7.29	8.96	8.87	5.68	8.75	7.71^{cd}
12	7.21	8.53	7.21	5.46	7.87	7.25^{d}
Mean	9.35^{a}	11.05^{a}	10.53^{a}	8.78^{a}	8.95^{a}	

^{abcd}Means followed by the same superscript are not significantly different ($P>0.05$).

Table 3. Mean %NDF and%ADF of elephant grass and its hybrids with advancing stages of maturity.

Maturity stage (weeks)	Forage type										Mean	
	KW_4		ILCA 16791		ILCA 16791		ILCA 16786		ILCA 16839			
	A	B	A	B	A	B	A	B	A	B	A	B
6	60.78	35.31	63.75	33.03	64.17	38.28	64.18	36.34	65.12	39.40	63.60f	36.47^{d}
7	64.07	37.64	65.21	42.11	66.16	40.38	67.12	41.49	67.82	44.02	66.07e	41.13^{c}
8	64.76	40.14	68.37	44.27	66.96	43.21	68.79	44.35	69.34	44.65	67.64d	43.32^{b}
9	65.72	42.86	69.06	46.70	69.26	45.43	66.37	46.45	66.42	47.38	68.56c	45.76^{a}
10	66.48	44.41	69.52	46.73	69.47	47.63	69.68	46.82	70.46	47.56	69.12b	46.63^{a}
11	69.87	45.31	70.42	46.87	70.79	46.91	70.79	47.11	70.79	47.64	70.53a	46.76^{a}
12	70.05	45.36	70.44	46.3	70.70	46.94	70.85	47.22	71.29	48.34	70.66a	46.81^{a}
Mean	65.96^{d}	41.57^{c}	68.11^{c}	43.70^{b}	68.21^{c}	44.11^{b}	68.68^{b}	44.25^{b}	69.17^{a}	45.57^{a}		

A= % NDF
B=% ADF
^{abcdef}Means followed by the same superscript are not significantly different (P>0.05).

Table 4. Mean % in vitro DM digestibility of elephant grass and its hybrids at different maturity stages.

Maturity stage (weeks)	Forages type					Mean
	KW_4	ILCA 16798	ILCA 16791	ILCA 16786	ILCA 16837	
6	66.51	68.66	67.40	65.70	66.08	66.87^{a}
7	60.50	59.29	57.30	59.45	62.39	59.79^{b}
8	54.19	58.44	53.33	53.03	56.02	55.00^{c}
9	51.68	53.13	49.81	46.73	47.56	49.78^{d}
10	47.82	47.71	46.99	44.44	42.58	45.91^{e}
11	43.66	42.55	43.47	42.24	42.22	43.23^{f}
12	42.22	41.30	41.88	40.42	41.91	41.55^{g}
Mean	52.37^{a}	53.01^{a}	51.45^{b}	50.57^{c}	51.25^{b}	

^{abcdefg} Means followed by the same superscript are not significantly different (P>0.05).

Table 5. Average DM consumption and apparent digestibility coefficients by mature sheep fed on elephant grass and its hybrids.

Item	Forages					S.E±
	KW_4	ILCA 16798	ILCA 16791	ILCA 16786	ILCA 16837	
DM Intake						
gm day^{-1}	586.4^{a}	545.8^{a}	577.2^{a}	584.3^{a}	505.3^{b}	47.8
gm $kg^{-1}/W^{3/4}$	42.59^{a}	43.65^{a}	41.40^{a}	43.47^{a}	35.55^{b}	5.24
%Body wt.	1.72^{a}	1.76^{a}	1.71^{a}	1.66^{a}	1.55^{a}	0.20
Apparent digestibility coefficients (%)						
DM	62.84^{b}	63.68^{a}	61.95^{b}	62.27^{b}	59.08^{c}	0.79
CP	62.25^{a}	59.34^{b}	60.90^{a}	59.60^{b}	63.21^{a}	3.94
NDF	44.36^{c}	46.03^{c}	60.22^{a}	55.45^{b}	56.49^{b}	3.61
ADF	55.94^{c}	56.39^{c}	65.63^{a}	60.29^{b}	63.9^{b}	0.84
Digestible energy content Kcal/gm	2.31	2.36	2.41	2.23	1.94	0.84

^{abc}Means followed by the same superscript are not significantly different (P>0.05).

Experiment 2

The DM intake (gm day^{-1} or gm kg^{-1} $W^{3/4}$ day^{-1}) for ILCA 16837 was lower ($P<0.05$) than for the other forages (Table 5). However DM intake as % body weight was similar ($P>0.05$) among the forages. Dry matter digestibility coefficient for ILCA 16837 was significantly ($P<0.05$) lower than for the rest of the forages, which could explain its low intake. Digestibility of CP differed ($P<0.05$) among forages, with KW4, ILCA16791 and ILCA 16837 having higher ($P<0.05$) values than the others. The digestibility of fibre fractions differed among forages with ADF digestibility being consistently higher than for NDF in agreement with results of Thomas *et al.* (1980). Digestible energy content was not significantly different ($P>0.05$) among forages but ILCA16837 had the lowest.

References

AOAC, 1990. Official Methods of Analysis. 15th ed. Association of Official AnalyticalChemists. Washington DC, USA.

Barnes, R.F. 1969. Collaborative research with 2-stage technique. Proceedings National Symposium on Forage Quality and Utilization, Lincoln, Nebraska.

Goering H.K. and Van Soest, P.J. 1970. *Forage Fibre Analysis*. US Department of Agriculture. USDA Agricultural Handbook No. 379 Washington, DC.

Duncan, D.B. 1955. Multiple Range and Multiple F-test. Biometrics: 11:1-42

Hassan, N.I., Osman, F.A. and Rammah, A.M. 1983. Morphological characters, chemical composition and *in vitro* dry matter disappearance of new varieties of Napier grass grown in Egypt. World Review Animal Production 19 (14):35-40

Marshall,B., Lonr, M.I.E. and Thornton, D.D. 1969. Nutritive value of grasses in Ankole and Queen Elizabeth National Park, Uganda. III. *In vitro* dry matter digestibility. Tropical Agriculture Trinidad, 46:43-46.

Minson, D. J. 1971. The nutritive value of tropical pastures. Journal of Australian Institute Agricultural Science 37:255-264.

Muinga, R.W., Thorpe, W. and Topps, J.H. 1993. Lactational performance of Jerseycows given Napier fodder (*Pennisetum purpureum*) with and without protein concentrates in the semi-humid tropics. Tropical Animal Health Production 25:118-128.

Ogwang, B.H. 1974. Quantitative and qualitative evaluation of *Pennisetum purpureum* x *Pennisetum typhoides* hybrids. MSc. Thesis, Makerere University.

Olsen, F.J. and Moe, P.G. 1971. The effect of Phosphate on establishment, productivity, nodulation and persistence of *Desmodium intortum*, *Medicago sativa* and *Stylosanthes gracilis*. East Africa Agricultural and Forestry Journal 37:29-40

Patterson, D.D. 1953. The influence of time of cutting on the growth, yield and composition of tropical grasses. I. Elephant grass. Journal Agricultural Science Cambridge 23:615-641.

Reid, R.L., Post, A.J., Olsen, F.J. and Mugerwa, J.S. 1973. Studies on the nutritional quality of grasses and legumes in Uganda. I. Application of *in vitro* techniques to species and stage of growth effects. Tropical Agriculture Trinidad 50:1-15.

Samaanya, J.P. 1996. Evaluation of feed resources for the zero grazing dairy production system in the fertile Lake crescent zone of Uganda. A case study of Jinja Women Heifer Project. M.Sc. Thesis, Makerere University. 174pp.

Thomas,C., Njoroge, P.K. and Felon, J.S. 1980. Prediction of digestibility in three tropical grasses. Tropical Agriculture Trinidad 57:75-81.

Tilley, G.E.D. 1970. Pasture research at Kawanda Station, Kampala. Kawanda Report.

Tilley J.M. and Terry, R.A. 1963. A two-stage technique for the *in vitro* digestion of forage crops. Journal British Grassland Society 18:104-111.

Van Soest, P.J. 1994. *Nutritional Ecology of the Ruminant*. 2nd Ed. Comstock Publishing Association, Cornell University Press, Ithaca. 476p

Vicente-Chandler, J., Silva, S. and Figarella, J. 1959. The effect of nitrogen fertilisation and frequency of cutting on the yield and composition of three tropical grasses. Agronomy Journal 51:202-206.

Watkins, J.M. and Van Severen, M.L. 1951. Effect of frequency and height of cutting on the yield stand and protein content of some forages in Salvador. Agronomy Journal 43; 191-296

Williams, C.N. 1980. Fertilizer response of napier grass under different soil conditions in Brunei. Experimental Agriculture 16:415-423.

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