Dry Matter Intake, Digestibility and Milk Yield by Friesian Cows Fed Two Napier Grass Varieties

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ABSTRACT : The objective of this study was to compare two varieties of Napier grass (Bana Napier grass vs French Cameroon Napier grass) and to determine whether feed intake, digestibility, average daily gain (ADG) and milk yield of lactating Friesian cows from fresh cut Bana Napier grass was greater than from French Cameroon Napier grass, using a completely randomized design. Results show that Bana Napier grass had similar percent dry matter (DM), ash and gross energy (GE) to French Cameroon. Bana grass had higher percent crude protein (CP) and lower fiber fractions, acid detergent fibre (ADF), neutral detergent fibre (NDF) and lignin compared to French Cameroon. Overall the forage quality was marginally higher in Bana Napier grass compared to French Cameroon. The DM and NDF intake expressed as a percentage of body weight (BW) were similar in both Napier grass types. Both grasses had similar digestible DM and energy. Bana had higher digestible CP but lower digestible ADF and NDF than French Cameroon. Bana Napier was not different from French Cameroon when fed as a sole diet to lactating cows in terms of low DM intake, milk yield and a loss of BW and condition. To improve the efficient utilization of both Napier grass varieties, a supplement capable of supplying 1085-1227 g CP/d and 17.0-18.0 Mcal ME/d is required for cows to support moderate gains 0.22 kg/d and 15 kg 4% fat corrected milk/d. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 4 : 516-521)***

Key Words : Napier Grass, Friesian Cows, Intake, Lactation

INTRODUCTION

Napier grass (*Pennisetum purpureum*) also called elephant grass, Taiwan grass, or King grass thrives in tropical and sub-tropical regions with a wide range of annual moisture (750-2,500 mm rainfall) in South America, Asia and Africa. It was introduced into East Africa to be used as a mulch crop in coffee plantations and a soil conservation agent on hillside terraces. Inadvertently it was converted to cattle feed as pastures were displaced by food crops. Napier grass is a robust perennial which forms large broad clumps, and grows to a height of 3 m in suitable soils (clay loams) and adequate moisture (Whiteman, 1980).

The average DM yield in Kenya of most Napier varieties is 15-40 ton/ha/year. Napier grass on average contains 20% DM and 8-10% CP, 70% NDF and 45% ADF (Mukisira and Khasiani, 1989). Two common varieties in western Kenya are Bana and French Cameroon. Bana is characterised by short succulent stems with broad leaves and has the least tendency to be stemmy at maturity of 10-12 months (Goldson, 1977). French Cameroon originated from Cameroon, it is tall (over 3 m), stemmy and hairy. The fodder is extensively grown across Kenya, being one of the earlier varieties introduced (Mwakha, 1972). Unfortunately, the hairy nature of the plant traps moisture thus creating a suitable micro-environment for a fungal infestation (white mold, *Spharaedea beniwoskia)*.

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There is agronomic data on Napier grass, but little pertaining to animal performance (Mbugua, 1993). In addition, there has been little effort to improve Napier's feeding quality. Breeding for disease resistance for many years has hindered attempts to select genotypes with improved digestibility. Judging a forage solely by DM yield rather than animal performance (DM intake, digestibility, milk yield or average daily gain (ADG)) could give an erroneous evaluation.

Ruminant production from forages is directly related to both voluntary DM intake and digestibility (Minson, 1990). Thus, the determination of the voluntary intake of forages is one means to identify fodders with high production potential. The objective of this trial was to determine whether the feed intake, digestibility and milk yield from fresh cut Bana was greater than from French Cameroon Napier grass.

MATERIALS AND METHODS

Animals, feeds and feeding

Two varieties of Napier grass, Bana and French Cameroon, were evaluated for their effects on DM intake, nutrient utilization and milk production, using ten Friesian cows (British ancestry) in their 2nd or 3rd lactation (15 kg FCM/d, at peak lactation). Their initial body condition score was 3 (on a 5 point scale). These cows were allocated to the two treatments in a completely random design with five cows per treatment. The cows were 60-70 d in milk at the beginning of the trial, they were milked twice daily, at

06:00 and 15:30 h. All cows were drenched with an antihelminthe (levamisole hydrochloride-oxycylozanide) at the start of the experiment. They were sprayed weekly with an acaricide following live weight measurements at 09:00 h. The experimental cows were individually housed at the National Agricultural Research Center, Kitale, Kenya.

Bana and French Cameroon were strip harvested at their equivalent stages of maturity (10 and 13 weeks growth, respectively. This is because the two varieties have different equivalent maturity stages ie Bana is maturing at 10 wks (early) while French Cameroon matures at 13 wks. To compare their performance at the same chronological age would give one forage undue advantage). Both grass types were freshly chopped into 2-3 cm lengths using a rotor-blade mounted on a tractor, weighed and fed to each cow in a wooden trough (100 cm long, 50 cm wide and 50 cm deep). The forage was well mixed prior to feeding twice a day. A mineral block and salt were provided free choice except during the fecal collection period. The mineral block contained 27% salt, 18.5% Ca, 11% P, 3% Mg, 0.5% Fe, 0.16% Cu, 5,000 ppm Zn, 400 ppm S, 200 ppm Co, 200 ppm I, 15 ppm Se and 2 ppm Mo. The grasses were fed *ad libitum* daily during the 10 d adjustment period and the 10 d voluntary intake period. The fecal collection period was 7 d. Milk yield and sampling was recorded from d 27 to 37. The cows were fed for a total of 37 d. Water was provided *ad libitum* in a water trough for each cow. All cows were fed and milked in the tie stall shed.

Sample preparation and laboratory methods

Forage samples were collected at each feeding and composited daily. Feces were manually collected and weighed. Total fecal output for each d was mixed, sampled and stored (-15°C) for compositing and analysis. A second sample was dried (55°C, 72 h) to determine percentage fecal DM. Feed samples were dried in a forced air oven (55°C, 72 h) then ground in a Wiley mill using a 1 mm screen. The morning and evening milk samples were composited and stored (4°C) for milk protein and fat analyses. All samples were analyzed for moisture, Kjeldahl N from which CP was calculated as total N×6.25, total ash, ether extract, calcium and phosphorus according to the procedure of AOAC (1984). Neutral (NDF) and acid detergent fibers (ADF) and lignin were determined according to the procedure of Van Soest et al. (1991). The NDF procedure was modified to include incubation with a heat stable alpha-amylase. Milk fat, milk N from which milk protein was calculated as N×6.38 and milk total solids were analyzed according to the procedure of AOAC (1990).

Statistical analysis

The data was analyzed as a completely randomized design by the GLM procedure of the SAS Institute, Inc. (1990). Where the F-test indicated significance ($p<0.05$), the treatment means were differentiated by the Least Significant Difference (LSD) procedure (Steel and Torrie, 1980).

RESULTS

Composition of bana and french cameroon napier grass varieties

The composition of Bana and French Cameroon forages is shown in table 1. The results indicate that the DM and gross energy (GE) content in Bana grass was not different ($p>0.05$) from that in French Cameroon grass. Bana grass had a higher ($p<0.05$) CP content (7.2%) than French Cameroon (6.1%). French Cameroon grass contained higher ($p<0.05$) cell wall fractions: ADF (50.3 vs. 45.5%), NDF (78.6 vs 71.4%) and lignin (7.0 vs 5.5%) than Bana grass, respectively.

Intake and digestibility of bana and french cameroon napier grass varieties

Intake and digestibility of Napier grass varieties are given in table 2. There was no difference ($p>0.05$) in DM and NDF intake between the two Napier grass varieties. The NDF intake expressed as a percentage of body weight (BW) was also not different ($p>0.05$). The digestibility of the DM, energy and NDF fractions were not higher ($p>0.05$) in Bana compared to French Cameroon. The digestible ADF was greater in French Cameroon by 5.5%, while the digestible CP was higher in Bana grass by 7.3% ($p<0.05$).

Milk yield and composition from cows fed bana and french cameroon napier grass varieties

The milk yield and composition and changes in BW of cows fed two Napier grass varieties are shown in table 3. Cows fed Bana Napier grass produced numerically more milk than those fed French Cameroon by 1.1 kg/d of 4% fat

Table 1. Composition of Bana and French Cameroon Napier grass varieties

Item (% DM basis)	Napier grass varieties		
	Bana grass	French Cameroon	SEM [1]
Dry matter	20.1	21.4	0.60
Crude protein	7.2 [a]	6.1 [b]	0.10
Acid detergent fiber	45.5 [b]	50.3 [a]	0.20
Neutral detergent fiber	71.4 [b]	78.6 [a]	0.50
Ash	9.3	9.3	0.20
Lignin	5.5 [b]	7.0 [a]	0.05
Gross energy (Mcal/kg DM)	3.93	4.01	0.06

[a,b] Means in the same row with different letters are different at $p<0.05$.

[1] SEM = standard error of mean (n=5).

Table 2. Dry matter intake and digestibility of Bana and French Cameroon Napier grass varieties

Item	Napier grass varieties		
	Bana grass	French Cameroon	SEM [1]
Body weight (kg)	403.5	370.2	20.8
Intake			
Dry matter (kg/d)	9.1	8.4	0.5
Dry matter (%, body weight)	2.25	2.26	0.2
Neutral detergent fiber (%, body weight)	1.7	1.8	0.1
Digestibility (%):			
Dry matter	57.5	57.6	1.8
Crude protein	59.9[a]	52.6[b]	2.0
Acid detergent fiber	52.5[b]	58.0[a]	1.7
Neutral detergent fiber	54.5	59.4	2.0
Digestible energy (Mcal/kg, DM)	2.22	2.31	1.8

[a,b] Means in the same row with different letters are different at $p<0.05$.

[1] SEM=standard error of mean (n=5).

Table 3. Milk yield and composition from cows fed Bana and French Cameroon Napier grass varieties

Item	Bana	French Cameroon	SEM [1]
Milk yield [2] (kg/d)	9.3	7.1	0.92
Fat corrected milk yield (4% FCM, kg/d)	7.9	6.8	0.84
Milk protein (%)	2.8	2.9	0.04
Milk fat (%)	3.02 [b]	3.25 [a]	0.07
Dry matter intake/100 kg 4% FCM	122.4	134.1	16.5
Body condition score[3] (final)	1	1	-
Body weight change (kg/d)	-0.89	-0.53	0.18

[a,b] Means in the same row with different letters are different at $p<0.05$.

[1] SEM = standard error of mean (n=5).

[2] Pre-test average milk yield was 10 kg/d (4% FCM).

[3] Body condition score based on a scale of 1 (thin) to 5 (fat), the initial score was 3.

corrected milk (FCM) however, that difference was not significant ($p>0.05$). Milk protein was not different ($p>0.05$) between treatments. However, milk fat was lower ($p<0.05$) from cows fed Bana (3.02%) compared to (3.25%) those fed the French Cameroon Napier grass. The DM intake per 100 kg of 4% FCM in cows fed Bana grass was not different ($p>0.05$) from those fed French Cameroon, neither were losses in BW different ($p>0.05$).

DISCUSSION

Phenotypically Bana grass has relatively wider, larger leaves and greater leaf:stem ratio at similar stages of growth compared to French Cameroon. Thus Bana Napier grass was expected to have a higher percentage CP but lower cell wall fractions (NDF, ADF and lignin) than French Cameroon Napier as observed in this experiment. Thus the phenotypic characteristics of Bana were reflected in the chemical analysis (table 1). The chemical analyses obtained for both Napier grasses in this experiment were similar to those of Brasilian Napier grass 71.4% NDF, 50.1% ADF and 11.5% ash (Devasena et al., 1993) and 74.2% NDF and 7% lignin (Anindo and Potter, 1994). The higher N content in Bana grass (7.2 vs 6.1% CP, $p<0.05$) may support more microbial rumen activity than in French Cameroon fed cattle if energy supply is not limiting in the rumen. The protein intake in both diets was 512 to 655 g/cow/d compared to a requirement of 900-1,050 g CP/cow/d, for 15 kg 4% FCM (NRC, 1989).

Bana's phenotypic characteristics were not reflected in the voluntary DM intake which was the same for both Napier grasses (2.3% BW). However, this intake level of the Napier grasses was only slightly less than the target intake (2.6% BW) recommended for a typical *bos indicus/bos taurus* cross with 400 kg BW (NRC, 1989). For a cow to produce 8.0 kg 4% FCM and make moderate gains of 0.22 kg/d, it ought to consume at least 10.4 kg feed DM (12% CP and 28% NDF). In other trials involving Napier grass the DM intake was similarly low. Grant et al. (1974) obtained an average DM intake of 2.2% BW in cattle while Muinga et al. (1992) reported DM intakes of 2.3% BW in Aryshire-Brown-Swiss-Sahiwal crosses fed Napier grass as the sole diet. Devasena et al. (1993) observed the DM intake to be only 1.34% BW (444 g DM/d) in rams. In this trial both Napier grass varieties had lower CP% and higher NDF% than is required for lactating cattle. These studies consistently show that DM intake is limiting in Napier grass fed cattle. However, these low intakes appear to be the most the cows can consume given the high NDF content (71-78%). The NDF intake from Napier grass diet was 1.7-1.8% BW which was higher than the maximum 1.1-1.2% BW (Mertens, 1983; Combs, 1992) recommended for cattle. High levels of cell wall fiber (NDF and ADF) in forages depresses both feed intake and digestibility (Van Soest, 1982).

Besides cell wall content in forages, low DM intake can also result from diets low in protein and high in moisture. Low protein content in feeds such as was found in both Napier grasses, can result in reduced rumen microbial growth rates, slow rates of particle degradation, depressed digestibility and ultimately low DM intakes (NRC, 1989).

In this trial there was no difference ($p>0.05$) in the

digestibility of DM, GE and NDF between Bana and French Cameroon forages. Digestible CP was higher ($p<0.05$) in Bana than in French Cameroon but digestible ADF was higher in the later grass. The higher digestibility of protein in Bana may have resulted from the greater protein content (7.2 vs 6.1% CP) in Bana compared to French Cameroon, however both grasses had similar ($p>0.05$) DM digestibility (58%). Similar results have been obtained in other studies, in which the Napier grass DM digestibility ranged from 53 to 57% (Grant et al., 1974; Rajab et al., 1991; Mbugua 1993).

This low DM digestibility (average 58%) placed both grasses in the range where forage "fill" would be the limiting factor to DM intake. The level of milk production (6-8 kg 4% FCM) observed in Napier grass fed cattle was less than the maximum possible from the Friesian cows. In addition, the loss in BW 530-890 g/d, accompanied by a drop in body condition score from 3 to 1 over a 37 d feeding period reflects the effects of both low DM intake and poor quality forage. The results in this trial confirm those of Muinga et al. (1993), who observed cows lose up to 600 g BW daily on a Napier grass diet. Such large losses in BW for lactating cows are indicative of low nutritive value of Napier grass as a dairy animal feed. Adjusting the diet by substituting a portion of the Napier grass by an energy/protein supplement may increase intake, digestibility, milk yield, composition and body condition.

High moisture content in feeds, especially silages can reduce intake (NRC, 1989). Forages with high moisture content (~80%) have been known to limit voluntary intake in cattle (Minson, 1990). It follows that the high moisture content of both Napiers (79-80%) may have contributed towards the low DM intake observed in agreement with the observations by Grant et al. (1974). In their study, voluntary DM intake of Napier grass by cattle and buffaloes increased by 15% following wilting of forage (88.0 to 85.4% moisture content). Wilting Napier grass prior to feeding could be incorporated as a management tool to increase intake.

Prior to the experiment, these cows were grazed on an early bloom *Chloris gayana/Setaria sphecelata* pasture (13-19% CP, 8-12 weeks growth, 18-22% DM) and their average milk yield was 10 kg/d. The low milk yield (6-8 kg/d) together with BW loss reflected the combined effects of reduced DM intake and low quality feed. Milk fat was lower (3.02%) from Bana versus (3.25%) from French Cameroon fed cows, a reflection of the differences in fiber levels in these forages (71.4% NDF and 45.5% ADF in Bana grass vs. 78.6% NDF and 50.3% ADF in French Cameroon Napier). Fiber intake was not limiting in either Napier grass variety. Both the percentage milk fat and protein obtained from Napier grass fed cows was lower than (3.1% CP and 3.4% milk fat) observed from barley silage fed cows (Fehr and Christensen, 1996). The low milk fat and protein content was a product of deficiency in both of protein and energy in the Napier grass diet.

Analysis of energy intake for cows fed napier grass

The calculations in table 4 indicate that Napier grass DM intake and digestibility were both limiting for the desired level of milk production (15 kg/d, 4% FCM) from pasture fed cattle (Whiteman, 1980) compared to the observed (6.8 and 7.9 kg/d, 4% FCM). An energy deficit affected body condition, as, at the end of the trial the animals were in a poor body condition (body condition score 1 and 2). Poor body condition is a predisposing factor to degenerative diseases, poor reproductive cycling (intermittent heat periods and inability to conceive or/and successfully carry fetus to term) environmental stress (time heat and high humidity) and inability to cope with pests. If the cows were to gain 220 g/d and milk yield is to be increased to 10 kg/d then the extra ME required in the supplement ought to be 9.8 and 10.3 Mcal for Bana and French Cameroon diets, respectively. However, if production is to be elevated to a more profitable level (15 kg/d) then the extra ME intake will have to be 18.0 and 17.0 Mcal for Bana and French Cameroon forages,

Table 4. Analysis of daily energy intake (ME Mcal) of cows fed Bana and French Cameroon Napier grass

Item	Napier grass varieties	
	Bana grass	French Cameroon
Diet description and intake		
Digestible energy (Mcal/kg)	2.22	2.31
Metabolizable energy[1] (Mcal/kg)	1.82	1.89
Total digestible nutrients (TDN, %)	50.5	52.4
Dry matter intake (kg/d)	9.1	8.4
Total ME intake (Mcal)	16.56	16.06
Requirement		
400 kg cow ME_m (Mcal)	12.0	12.0
Lactation ME_L[2] (Mcal)	9.87	7.86
Total requirement (ME_m+ME_L) (Mcal)	21.88	19.87
Balance		
ME balance (intake-requirement) (Mcal)	-5.32	-3.81
Body weight change	-0.89	-0.53
Supplemental ME required[3] (Mcal)	18.0	17.0

[1] ME (Mcal/kg DM)=0.82 DE (NRC, 1989).

[2] Lactation ME (Mcal) requirement: 1.24 Mcal/kg 4% FCM (NRC, 1989).

[3] Supplemental ME required to support 15 kg milk/d+220 g/d gain.

respectively; for a total ME intake of 32.6 Mcal.

Analysis of crude protein intake for cows fed Napier grass

Table 5 shows the analysis of CP intake and the changes in BW. For cows weighing approximately 400 kg (BW) with daily milk yield 7.9 and 6.8 kg FCM, CP intake should be 1034.4 and 888.6 g/cow/d, respectively, to meet both lactation and maintenance requirements. The CP intake deficit was -379.2 g and -376.2 g for Bana and French Cameroon diets, respectively. To supplement forage protein the concentrate will have to supply 1085 g CP (Bana diet) and 1227 g CP in the French Cameroon diet.

The supplemental protein should consist of 36.6% undegradable intake protein and 63.4% degradable intake protein in order to maximize the efficiency of protein utilization by both the rumen bacteria and digestion in the lower gut (NRC, 1989). In addition the concentrate for both diets should also contain 17-18 Mcal ME, calculated in the preceding section.

CONCLUSION

Bana Napier grass had similar percent DM, ash and GE to French Cameroon. Bana Napier grass had a higher CP% and lower fiber fractions (ADF and NDF) and lignin compared to French Cameroon. Overall the forage quality was marginally higher in Bana Napier grass compared to French Cameroon.

The DM and NDF intake (% BW) were similar in cows fed both Napier grass types. Both Bana and French Cameroon Napier grasses had similar digestible DM and energy. Bana had higher digestible CP but lower digestible ADF and NDF than French Cameroon. Bana Napier grass was not different from French Cameroon when fed as a sole diet to lactating cows in terms of low DM intake, milk yield and a loss of BW and condition.

To improve the efficient utilization of both Napier grass varieties, a supplement capable of supplying (1,085-1,227 g CP/d and 17.0-18.0 Mcal ME/d) is required for cows to support moderate gains 0.22 kg/d and 15 kg FCM/d.

Table 5. Analysis of crude protein intake of cows fed Bana and French Cameroon Napier grass

Item	Napier grass varieties	
	Bana grass	French Cameroon
Forage crude protein (%)	7.2	6.1
Milk yield (4 % FCM[1]) (kg/d)	7.9	6.8
DM intake (kg/d)	9.1	8.4
CP intake (g/d)	655.2	512.4
400 kg cow (CP maintenance requirement) (g/d)	318.0	318.0
Lactation requirement CP[2] (g/d)	716.4	570.6
Total requirement (Maintenance+Lactation) (g/d)	1034.4	888.6
Net CP balance (g/d)	-379.2	-376.2
Observed BW changes[3] (g/d)	-890.0	-530.0
Protein required to support 220 g BW gain (g/d)	70.4	70.4
Protein to increase milk yield to 15 kg FCM (g/d)	635.0	780.0
Supplemental CP for 15 kg milk+ 220 g BW gain (g/d)	1085.0	1227.0

[1] Fat corrected milk (4% milk fat).

[2] Lactation requirement of crude protein: 90 g/kg 4% FCM (NRC, 1989).

[3] Observed loss in body weight in experimental cows.

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