Daily intake of lactating crossbred cows grazing elephant grass rotationally[1]

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Abstract – The goal of this trial was to estimate the total dry matter (TDMI) and daily pasture dry matter intakes (PDMI) by lactating crossbred Holstein – Zebu cows grazing elephant grass (*Pennisetum purpureum* Schum.) paddocks submitted to different rest periods. Three groups of 24 cows were used during two years. The paddocks were grazed during three days at the stocking rate of 4.5 cows/ha. Treatments consisted of resting periods of 30 days without concentrate and resting periods of 30, 37.5 and 45 days with 2 kg/cow/day of 20.6% crude protein concentrate. From July to October, pasture was supplemented with chopped sugarcane plus 1% urea. Total daily dry matter intake was estimated using the extrusa *in vitro* dry matter digestibility and the fecal output with chromium oxide. Regardless of the treatment the estimated average TDMI was 2.7, 2.9 and 2.9±0.03% and the mean PDMI was 1.9, 2.1 and 2.1±0.03% of body weight in the first, second and third grazing day, respectively ($P<0.05$). Only during the summer pasture quality was the same whichever the grazing day. Sugarcane effectively replaced grazing pasture, mainly in the first day when pasture dry matter intake was lowest.

Index terms: *Pennisetum purpureum*, digestibility, extrusion, dry matter content, feed grasses.

Consumo diário de vacas mestiças em lactação em pastejo rotacionado de capim-elefante

Resumo – O objetivo deste trabalho foi o de estimar o consumo total e o diário de matéria seca do pasto, de vacas mestiças Holandês – Zebu, em piquetes de capim-elefante (*Pennisetum purpureum* Schum.). Três grupos de 24 vacas foram usados em piquetes (4,5 vacas/ha), pastejados por três dias e submetidos a diferentes períodos de descanso durante dois anos. Os tratamentos consistiram de descansos de 30 dias sem concentrado e 30, 37,5 e 45 dias com a suplementação de 2 kg de concentrado (20,6% de proteína bruta). De julho a outubro, as vacas receberam, como suplementação, cana-de-açúcar mais 1% de uréia. O consumo total de matéria seca foi estimado a partir da digestibilidade *in vitro* da matéria seca da extrusa e da produção fecal obtida com óxido crômico. Independentemente do tratamento, o consumo total foi 2,7; 2,9 e 2.9±0,03%, e o consumo de matéria seca do pasto foi de 1,9; 2,1 e 2,1±0,03% do peso vivo ($p<0,05$), respectivamente, no primeiro, segundo e terceiro dia de ocupação do piquete. Somente no verão, o consumo do pasto foi semelhante nos três dias de pastejo. A mistura cana-de-açúcar e uréia substituiu o pasto, principalmente no primeiro dia de pastejo, ocasião em que o consumo do pasto era mais baixo.

Termos para indexação: *Pennisetum purpureum*, digestibilidade, extrusão, conteúdo da matéria seca, gramíneas forrageiras.

Introduction

Pennisetum purpureum Schum. known as Elephant grass or Napier grass is a tall erect perennial tropical grass, with thick stems up to 4.5 m high, found on moist soils in areas with over 1,000 mm of annual rainfall. Elephant grass grows best on deep soils of moderate to fairly heavy texture and tolerates short droughts, but does not withstand waterlogging. It yields very large quantities of dry matter,

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but is low in protein content unless cut very young. It should not be cut closer than 10-15 cm from the ground. Under normal management, stands are invaded by weeds and "run out" after two or three years so that they have to be ploughed up and replanted (Tropical Feeds, 1999).

Although traditionally used as chopped grass in Brazil, there is evidence of the great potential of elephant grass as pasture. Results of milk production with crossbred cows grazing elephant grass, at Embrapa-Centro Nacional de Pesquisa de Gado de Leite, in Brazil, between 10,000 and 15,000 kg/ha, during the 180 days of rainy season, were reported by Deresz (1994) and Coser et al. (1996). However, elephant grass shows a high stocking rate only during the rainy season, since forage production is drastically reduced in the dry months. In South-eastern Brazil, elephant grass dry matter availability decreases from over 3,500 kg/ha in November, to less than 500 kg/ha in July (Aroeira et al., 1999). One of the alternatives to minimize this problem is the supplementation with chopped sugarcane.

Sugarcane is readily available as forage for dairy cattle and is used as a strategic supplementation particularly during the dry season. Both the sugar and fiber contents of sugarcane are high, but protein and lipid contents are very low (Valadares Filho et al., 1990; Aroeira et al., 1993). Milk productions over 15,000 kg/ha/year were reached with cows grazing elephant grass supplemented with sugarcane plus urea mixture during the dry season (Deresz & Mozzer, 1990).

The objective of this trial was to estimate the daily composition of extrusa, dry matter and elephant grass dry matter intakes of lactating crossbred Holstein – Zebu cows grazing paddocks submitted to different resting intervals.

Material and Methods

The trial was carried out from April 1992 to October 1993 at Embrapa-Centro Nacional de Pesquisa de Gado de Leite, in Minas Gerais State, Brazil, at approximately 22° latitude South and 43° longitude West, at an average altitude of 426 m. In this region there are two well-defined seasons. The dry season lasting from April/May to September/October characterized by average temperatures of 17°C and scarce rainfall (60 mm per month). The rainy season lasts from October to March, with average temperature of 24°C and monthly rainfall of about 230 mm.

As in all South hemisphere, in Brazil the autumn months are March, April and May, the winter months are June, July and August, the spring months are September, October and November and the summer months are December, January and February.

An area of 5.3 ha planted with elephant grass (*Pennisetum purpureum* Schum.) was used. The pasture was fertilized with 200 kg of N, 200 kg of K_2O, 40 kg of P_2O_5 and 1,000 kg of dolomite limestone per ha/year. Nitrogen and K fertilizers were applied in November, January and March. The limestone and phosphorous were hand distributed in November.

Three groups of 24 crossbred Holstein – Zebu cows each were used. These had an average of 45 to 60 days in milk, in their second or third lactation, and averaged 483±5.3 kg of live weight. The first group of cows calved in February or March and entered the experimental area in April and remained until October (1992). The second group calved in August or September and stayed in the experimental area from October to April 1993. The third group calved in February or March and remained in the experimental area from April to October (1993). These animals were blocked taking into account the milk yield and live weight data from the pre-experimental period. A total of six cows per treatment (three per replication) were kept at all times. The cows were milked twice a day, at 7 a.m. and 2 p.m. and had free access to a mineral mixture and water before milking.

The area planted with elephant grass was divided into paddocks, alternately grazed for three consecutive days, and allowed different resting periods, making up the four experimental treatments, replicated twice, as follows: resting period of 30 days without concentrate supplementation (30W) and resting periods of 30 (30C), 37.5 (37.5C) and 45 (45C) days with concentrate supplementation. The number of paddocks and their areas varied according to the treatment in such a way that stocking rate was always about 4.5 cows/ha. Thus, for a resting period of 30 days, there were 11 paddocks of 607 m^2 each. For a resting period of 37.5 days, 13 paddocks of 494 m^2 and one paddock of 247 m^2 (grazed for one day and half) and for the 45 day resting periods, 16 paddocks measuring 417 m^2 each.

Concentrate (2 kg/cow/day) was supplied in two meals distributed at the milking times. It consisted of corn meal (65%), wheat bran (20%), cottonseed meal (10%), urea (2%), limestone (2%) and mineral supplement (1%). The average chemical composition of dry matter (DM) was crude protein (CP), 20.6%, neutral detergent fiber (NDF), 32.1% and acid detergent fiber (ADF), 8.7%.

From October to June elephant grass was the only roughage available to the cows. During the driest months (July to October) the animals grazed elephant grass during the night and were confined between milking, in separate corrals, according to treatment, where they received chopped sugarcane plus 1% urea (9 parts of urea and 1 part of ammonium-sulfate) *ad libtum*.

The daily intake measurements were taken 16 times during the entire experimental period. Intake was estimated in April, May (autumn), July, August (winter) September, November (spring) and December (summer) of 1992 and January, February (summer), March, April, May (autumn), July, August (winter), September, October (spring) of 1993. Two esophageal fistulated dry cows, adapted to the grazing conditions, without fasting, were used to estimate quality of the forage intake. Material collection (extrusa) was carried out on three consecutive days, while the experimental cows grazed the same paddock. The fistulated cows were maintained in extra paddocks, for at least two weeks before the first collection period, managed at the same way of the experimental area, to be adapted to the forage. The two cows were moved from paddock to paddock after the amount of forage sampled was achieved (1.5 kg/cow). The samples were collected in the morning, between 9 and 12 a.m., weighed and oven-dried at 65°C for 72 hours, before being analyzed for *in vitro* dry matter digestibility (IVDMD), following the method proposed by Tilley & Terry (1963).

The DM was determined at 100°C and the CP by the Kjeldahl method (Association..., 1990). The NDF and ADF were analyzed following the recommendations of Soest et al. (1991).

Fecal production was estimated using chromic-oxide (Cr_2O_3) as an external marker, at a rate of 10 g/animal/day, administered orally, wrapped in paper, with aid of a speculum, during 12 days, in two doses of 5 g each, immediately before milking times. Feces were collected fresh twice a day directly from the concrete floor or by rectal grabbing, from the 6th to 12th day while chromium was administered. Daily samples from the fecal collection period were pooled for analysis on an individual animal basis. Each sample was dried at 65°C, ground through 1 mm sieves and submitted to digestion by nitro-chloric acid, following the methodology proposed by Kimura & Miller (1952). After chemical digestion, chromium (Cr) was determined by atomic absorption spectrophotometry. Fecal production (FP) was then calculated using the formula:

FP = Cr administered (g/day)/Cr in the fecal DM (g/kg).

Daily DM intake (DMI) was estimated using the formula:

DMI (g/day) = FP/(1-(digestibility/100)).

In the treatment where the diet was exclusively elephant grass, the formula above was applied directly. However, when the animals received the concentrate supplementation or when sugarcane plus urea was administered, the intake of this supplements was daily measured and the IVDMD of each feed was determined. The fecal output was separated by feed components and their fecal contribution was subtracted from the total fecal output. Elephant grass or herbage DMI was obtained by difference. Daily DMI was estimated with the extrusa IVDMD sampled at the first, second and third day of the occupation period and the fecal production was obtained 24 hours after that.

The experiment was conducted in a split-split plot design. Cows and treatments were arranged as main plots. Years were arranged as subplots and the seasons as split-sub-plots. The statistical analysis was carried out using the General Linear Model Procedures (GLM) of Statistical Analyses System (SAS Institute, 1993).

Results and Discussion

In both years elephant grass dry matter availability was different ($P<0.05$), according to the season (Table 1). The DM availabilities increased from winter to summer in both years. However, as the dry season (winter and spring) was more severe in 1993, daily herbage allowance in that period was lower ($P<0.05$) than in 1992.

Means DM availabilities of 2,423, 1,939 and 1,745±92 kg/ha of DM were observed for resting periods of 45, 37.5 and 30 days, respectively. No difference was detected ($P>0.05$) in average daily herbage allowances for the various resting periods, due to the different sizes and number of paddocks. The mean herbage allowance observed during the experimental period was 11.3±0.45 kg/cow/day of DM (Aroeira et al., 1999).

Similar elephant grass DM availability have already been described in Southeastern Brazil. In the same experimental area Soares (1998) reported 2,354 kg/ha of DM in March. Benedetti & Colmanetti (1997) recorded mean availability of 4,248 kg/ha of DM during the rainy season. On the other hand, Olivo et al. (1992) and Coser et al. (1996) observed annual averages from 2,000 to 2,500 kg/ha of DM, respectively.

Regardless of the treatment, season or experimental year, the highest CP mean values ($P<0.05$) were observed in the first grazing day (13.9%), followed by data obtained at the second (11.8%) and finally at the third grazing day (10.5%).

Mean cell wall content as measured as NDF was higher (P<0.05) in summer than all other seasons although there was no difference in IVDMD among them (Table 2). Elephant grass growth rates are higher in wet summers with most of the dry matter being cell wall (Passos, 1994). Other higher neutral detergent fiber contents in elephant grass during the rainy season were described in the literature (Anindo & Potter, 1994; Soares, 1998).

In general, the mean IVDMD obtained at the first day were similar among treatments (P>0.05), and higher (P<0.05), than that observed at the second day, except during the summer. The data recorded at the third day were the lowest ones. Regardless of the season of the year, average chemical composition of extrusa varied (P<0.05) according to the grazing day, as shown in Tables 2 and 3. It is suggested that warmer temperatures (Soest, 1994) associated with selective grazing, resulted in increased levels of NDF and ADF, simultaneously as CP and IVDMD decreased.

Selective grass dry matter intake was the main factor since the changes were observed from the first through the third grazing days. During summer time extrusa IVDMD was similar during the second in relation to the first grazing day, probably because of more abundant rainfall. Nonetheless, other factors may have contributed to the chemical composition of elephant grass such as the amounts of rainfall and fertilizer applied, as well as soil composition and sampling methodology. Soares (1998) reported for the same area CP of 14.1 and 16.5, 14.1 and 19.1, 12.1 and 13.5 and 15.2 and 15.3% from an extrusa sample collected, respectively, during winter, spring, summer and autumn, from pastures fertilized with 300 and 700 kg/ha/year of nitrogen. In the present trial, extrusa composition varied also according to the grazing day and the experimental year, the IVDMD recorded in 1992 (59.5, 59.2 and 55.5%) were higher (P<0.05) than that observed in 1993 (53.7, 52.2 and 50.6%).

The data reported for extrusa composition were in general higher in quality than that described for samples of chopped elephant grass, as described by

Table 1. Elephant grass dry matter (DM) availability in 1992 and 1993, according to the season[(1)].

Season	1992		1993	
	DM/ha	DM/cow/day	DM/ha	DM/cow/day
	----(kg)----			
Autumn	1,864Bb	10.8Bb	2,582Aa	14.9Aa
Winter	1,332Ac	7.6Ac	547Bb	3.2Bc
Spring	2,161Aab	12.5Aab	1,680Bb	9.7Bb
Summer	2,633Aa	15.1Aa	2,950Aa	17.0Aa
Standard error	130	0.66	130	0.66

(1)Values with different letters differ significantly within line (upper case) or within column (lower case) at 5% of probability by Tukey test.

Table 2. *In vitro* dry matter digestibility (DMD), and neutral detergent fiber (NDF), as percentage of dry matter, from extrusa, according to the grazing day and season[(1)].

Grazing day	Autumn		Winter		Spring		Summer	
	DMD	NDF	DMD	NDF	DMD	NDF	DMD	NDF
	---- (%) ----							
1	59.6Aa	69.3Bc	58.1Aa	69.8Bc	48.7Bc	70.0Bc	60.0Aa	72.3Ab
2	55.9Bb	71.2Bb	54.9BCb	71.0Bb	53.9Ca	73.2Ab	58.1Aa	72.5Ab
3	53.8Abc	72.5Ba	52.3Bc	72.1Ba	50.8Bb	74.5Aa	55.3Ab	74.0Aa
Standard error	0.53	0.21	0.59	0.23	0.61	0.24	0.83	0.33

(1)Values with different letters differ significantly within line (upper case) or within column (lower case) at 5% of probability by Tukey test.

Anindo & Potter (1994) and Lopes & Aroeira (1998), probably due to the animal's allowance to select their diet from those samples.

Considering the experimental design used in this work the extrusa composition results (Table 2) showed differences regardless the resting periods. Therefore, taking into account the number of paddocks, the 30 days resting periods are recommended. In addition, paddocks grazed every 30 days showed higher CP content and lower NDF level, with no significant effect on dry matter intake or milk production, when compared to paddocks grazed every 37.5 or 45 days (Aroeira et al., 1999).

For DM intake calculation, feces produced 24 hours after the extrusa sampling were always used. For example, for the calculation related to the first day DMI, data from extrusa collected at the first grazing day in a paddock and fecal output of the third day grazed at the previous paddock were used. For the second day DMI, data used came from extrusa collected at that same day as well as fecal output from the first grazing day. The same procedure was adopted for the third grazing day. Data related to the fecal output collected 48 hours after the collected extrusa were not tested.

The average total dry matter intake as percentage of body weight (BW), independent of treatment, season or experimental year, differed ($P<0.05$) relatively to grazing day. Values of 2.86, 3.02 and 3.10±0.33% of the BW, respectively, were observed at the first, second and third grazing days (Table 4).

Pasture dry matter intake did not differ among treatments, except during the summer (Aroeira et al., 1999). However, the daily intake was different according to the season of the year. Pasture dry matter intake (Table 4) was highest during summer, lowest in winter and intermediate in autumn and spring. In general, PDMI increased significantly from the first to second and third grazing day, being the last two values similar. In addition, spring PDMI values were similar at the first and second days.

Total and pasture dry matter intake were higher during the summer probably due to more pasture availability and decreased during autumn due to the reduction of elephantgrass DM availability (Table 4). Total dry matter intake was higher again during winter due to sugarcane plus urea supplementation and remained high during spring when elephant grass resumed its growth (Table 1).

Considering the dry matter intake in relation to the three grazing days/paddock, the means TDMI and PDMI increased from the first to the third grazing day ($P<0.05$). These data differ from the literature. Higher forage intake should be expected in the first grazing day based on the pasture availability and forage quality (Table 2). However, the probable reasons for the results obtained in this trial, could be due to the following factors: a) higher forage NDF content observed at the third grazing day (Table 3); b) lower rumen passage rate due to inferior forage quality; c) higher rumen fill in the third grazing day.

During both dry seasons sugarcane plus urea was administered, as a roughage supplement to the cows between milking, in separated corrals, according to treatment. The sugarcane plus urea intake was recorded by weighing the offered and the refused feed every seven consecutive days, in each treatment group. Independently of treatment, the average sug-

Table 3. *In vitro* dry matter digestibility (DMD), and neutral detergent fiber (NDF), as percentage of dry matter (%), from extrusa, according to the grazing day and to resting periods of 30 days without (W) concentrate and 30, 37.5 and 45 days with (C) concentrate[(1)].

Grazing day	30W		30C		37.5C		45C	
	DMD	NDF	DMD	NDF	DMD	NDF	DMD	NDF
	(%)							
1	58.9Aa	69.9Bb	53.7Bab	69.4Bc	57.0Aa	71.1Ac	56.8Aa	70.9Ac
2	54.1Bb	71.9Ba	55.3Ba	70.9Cb	57.7Aa	72.3ABb	55.6Bab	73.0Ab
3	52.3Bc	72.6Ba	53.3Ab	73.2Ba	52.1Bb	73.1Ba	54.5Ab	74.3Aa
Standard error	0.63	0.24	0.63	0.24	0.62	0.24	0.64	0.24

(1)Values with different letters differ significantly within line (upper case) or within column (lower case) at 5% of probability by Tukey test.

Table 4. Total dry matter intake (TDMI) and pasture dry matter intake (PDMI), according to the season of the year and grazing day as percent of the body weight (% BW)[(1)].

Grazing day	Autumn		Winter		Spring		Summer	
	TDMI	PDMI	TDMI	PDMI	TDMI	PDMI	TDMI	PDMI
	(%)							
1	2.3Cb	2.1Bb	2.8Ba	1.1Db	2.9Bb	1.8Cb	3.4Ab	3.1Ab
2	2.6Ca	2.4Ba	3.0Ba	1.3Da	2.9Bb	1.8Cb	3.5Aab	3.3Aab
3	2.5Cab	2.3Ba	3.0Ba	1.4Da	3.2Ba	2.0Ca	3.7Aa	3.5Aa
Standard error	0.05	0.05	0.06	0.06	0.06	0.06	0.08	0.09

(1)Values with different letters differ significantly within line (upper case) or within column (lower case) at 5% of probability by Tukey test.

arcane dry matter intake was higher in the first than in the second and third grazing days, the latter two were similar. DM data collected as mean of treatment groups were 1.35, 1.29 and 1.29±0.01% BW for the first, second and third days, respectively. The highest ($P<0.05$) intake in the first day was possibly caused by a substitution effect, since pasture dry matter intake was lowest in the first day.

Cows body weight varied with the experimental treatments ($P<0.05$). Supplemented cows from the experimental treatments mean live body weight of 484±5.3 kg were heavier than unsupplemented cows (472±5.3 kg).

Conclusions

1. Forage intake in the first day is lower than that grazed in the third day.
2. Only in summer pasture quality is similar among grazing days.
3. During the dry season, sugarcane effectively replaces grazing pasture dry matter intake.

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