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Performance of Nellore steers grazing on *Panicum maximum* Jacq cv. Mombaça receiving chopped sugar cane tops and protein supplementation

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ABSTRACT. The aim of this study was to evaluate protein supplementation on the performance of steers grazing on Mombaça grass and receiving chopped sugar cane tops at a level of 0.80% of live weight (dry matter (DM) basis), during the dry season. Forage availability and quality of the experimental pasture were also evaluated. Thirty-two Nellore steers, weighing 300 kg (± 25.80) of initial live weight, eight per treatment, were used. The statistical design was completely randomized and each steer group was allocated to one of four paddocks (1.125 ha paddock^{-1}). All steers received a protein supplement at 0.40% of live weight (DM basis) and the four treatments consisted of the following four crude protein (CP) concentrations in supplements: 12.5, 25.0, 37.5 and 50.0% CP (DM basis). Average forage mass availability and green leaf blades availability were 10,069 and 2,195 kg of DM ha^{-1}, respectively. Average CP, neutral fiber detergent (NDF) and *in vitro* dry matter digestibility (IVDMD) in forage mass were 6.87, 62.63 and 49.80%, respectively. Average daily gain was 0.61 kg steer^{-1} day^{-1} and these results show that the strategy of feeding steers in pasture, with chopped sugar cane tops (0.80% LW) and protein supplement with 12.50% CP (0.40% LW), during the dry season, allows high gain per area (363 kg live weight ha^{-1}).

Key words: protein supplementation, beef cattle, tropical pasture.

RESUMO. Desempenho de novilhos Nelore em pastagem de *Panicum maximum* Jacq. cv. Mombaça recebendo cana-de-açúcar picada e suplementação proteica. No experimento foi avaliado o efeito da suplementação proteica sobre o desempenho de novilhos que pastejam capim Mombaça e recebem cana-de-açúcar picada, em nível de 0,80% do peso vivo (PV) (base matéria seca, MS). Também foram avaliadas a disponibilidade e a qualidade da forragem da área experimental. Foram usados 32 novilhos da raça Nelore, com peso inicial de 300 kg (± 25,80). O delineamento experimental foi inteiramente casualizado e cada grupo de novilhos foi alocado para cada um dos quatro piquetes (1,125 ha piquete^{-1}). Os animais receberam suplemento proteico em nível de 0,40% do PV (base MS) e os quatro tratamentos consistiam de suplementos com diferentes percentuais de proteína bruta: 12,5; 25,0; 37,5 e 50,0% (base MS). A disponibilidade média de massa de forragem e de lâminas foliares foi 10.069 e 2.195 kg de MS ha^{-1}, respectivamente. A proteína bruta, a fibra em detergente neutro e a digestibilidade *in vitro* da matéria seca na massa de forragem foram 6,87; 62,63 e 49,8%, respectivamente. O ganho médio diário foi de 0,61 kg novilho^{-1} dia^{-1}, e estes resultados mostram que a estratégia de suplementação de novilhos, com cana-de-açúcar picada (0,80% do PV) mais suplemento proteico com 12,5% de PB (0,40% do PV), durante a estação seca, permite alto ganho por área (363 kg de PV ha^{-1}).

Palavras-chave: suplementação proteica, gado de corte, pastagem tropical.

Introduction

Animal nutrition has generally been recognized as being basically dependent on four factors: animal requirements, feedstuff nutrient content and digestibility, and finally, animal feed intake. In this consideration, to optimize ruminant production from pasture it is necessary to adjust the seasonal deficit of nutrients required by the animals, and improve forage digestibility and intake, mainly through supplementation.

Tropical forages usually show nutritional deficiencies that depreciate while the plant matures and the effect is pronounced during the dry season. Forage growth is mainly dependent on temperature, light and precipitation. In tropical regions, during the dry season animal production is limited by quality and forage availability. Brazilian beef production systems are supported mainly by pasture, which increases the importance of a correct grazing management that allows animals to obtain essential nutrients for good performance.

Beef farms in Brazil have mainly cultivated pastures represented by *Brachiaria* and *Panicum* species, and nutritional deficiency during the dry season is commonly observed. Intake by range ruminants has a positive correlation with forage availability, implying that a reduction of forage availability can reduce feed intake. A curvilinear relationship between daily forage allowance and daily forage intake has been demonstrated in many experiments, as revised by Gibb (2006). From such relationships, it is evident that to achieve unrestricted daily intakes, daily allowances equivalent to between 3 and 4 times maximum daily intake must be provided. Low forage mass allowance can be partially compensated by longer grazing time; however, total forage intake by animals may remain negatively affected (DIAS et al., 2008).

Protein supplementation allows an increase in forage digestibility and intake (MOORE et al., 1999) in grazing systems. In cattle consuming low-quality forage, protein supplementation has consistently increased N retention (FARMER et al., 2004). In diets based on poor quality forages, protein supplementation can increase beef steers production (KIM et al., 2007), making it possible for animals to obtain higher gains on pasture.

This research was conducted to evaluate protein supplementation on the performance of Nellore steers grazing on Mombaça grass (*Panicum maximum* Jacq cv. Mombaça) and receiving chopped sugar cane tops during the dry season.

Material and methods

Thirty-two Nellore steers with average initial live weight of 300 kg (± 25.80) were used in a grazing experiment in which they received protein supplementation. The experiment was conducted in the Northwest of Parana State, Brazil, from May to September, 2003. The region's climate is classified as Cfa (PEEL et al., 2007).

Steers were randomly distributed into four treatments and grazed on Mombaça grass (*Panicum maximum* Jacq cv. Mombaça) using continuous grazing. All steers, regardless of treatment, were supplemented with chopped sugar cane at the rate of 0.80% of live weight (LW) on DM basis, and protein supplement at the rate of 0.40% of LW. Sugar cane composition (dry matter basis) was: 28.30% dry matter (DM), 4.52% crude protein (CP), 6.20% mineral matter (MM), 1.55% ether extract (EE), 34.10% acid detergent fiber (ADF), 7.60% lignin (L), 80.13% total carbohydrates (TC), and 43.88% neutral detergent fiber (NDF). IVDMD of chopped sugar cane was 50.37%. Treatments were four supplements with different concentrations of CP, as follows: 12.5, 25.0, 32.5 and 50.0% CP. In relation to LW, supplements supplied 0.05, 0.10, 0.15 and 0.20% of CP. Mineral salt was supplemented along with protein supplements. Chemical composition of feeds is shown in Table 1, and percent and chemical composition of supplements are shown in Table 2.

Table 1. Chemical composition of feeds (% DM).

Ingredients	Nutrients						
	% of dry matter						
	DM	CP	MM	EE	NDF	ADF	TDN
Soybean meal	88.4	48.5	6.0	1.6	12.0	9.0	84.0[1]
Soybean hulls	90.7	11.0	4.5	2.7	55.7	42.6	80.0[1]

[1]Estimated using NRC (2000).

There was an adaptation phase of 15 days, following which steers were randomly separated into four groups. Steers were weighted at the beginning of the experiment and then every 28 days after 14h of complete fasting. Considering chopped sugar cane and protein supplement, steers were fed at the rate 1.20% of LW. The amount of sugar cane and protein supplement fed was adjusted every 28 days considering the weight of steers. These data were then used to calculate the dry matter intake (DMI) and feed efficiency (FE) based on both supplements (chopped sugar cane and protein supplements).

Table 2. Ingredient and chemical composition of supplements (DM basis, %).

Ingredients	Protein content (%)			
	12.5	25.0	37.5	50.0
Soybean hulls (%)	95.32	87.40	70.18	47.81
Soybean meal (%)	------	3.36	17.76	37.67
Urea (%)	0.78	4.62	7.08	9.18
Ammonium sulfate (%)	0.06	0.78	1.14	1.50
Mineral salt (%)[1]	3.84	3.84	3.84	3.84
Total (%)	100.00	100.00	100.00	100.00
	Chemical composition of supplements (DM basis)			
MS (%)	91.10	91.50	91.40	91.20
CP (%)	12.80	25.60	37.90	50.70
EE (%)	2.60	2.40	2.20	1.90
MM (%)	4.30	4.10	4.20	4.40
NDF (%)	52.20	50.00	39.20	32.50
ADF (%)	40.60	37.50	31.50	23.80
TDN (%)[2]	76.10	72.50	70.80	69.80

[1]Mineral salt composition kg^{-1}: Ca 130 g; P 65 g; S 12 g; Mg 12 g; Na 135 g; Cu 155 mg; Zn 3080 mg; Mn 1050 mg; Co 63 mg; I 63 mg; Se 18.2 mg and Fe 2680 mg. [2]NRC (2000).

The experimental area, 4.50 hectares, consisted of four paddocks measuring 1.125 ha each. The area was divided by electric fences and had a permanent supply of water and feeding troughs strategically placed. The paddocks were not grazed for 50 days before the start of the experiment to guarantee a high availability of initial forage mass. The estimation of forage mass (FM) availability was done every 28 days after the start of grazing using the double sampling method (WILM et al., 1944). This involved randomly cutting four 1-m^2 samples per paddock at 20 cm above ground. Herbage samples were divided in two sub-samples, one to determine dry matter and another to evaluate plant components which were separated for green leaf blade (GLB), stem + green sheath (SGS) and dead material (DMT). Samples were then dried at 55°C for 72h and ground in a Willey mill (®Tecnal) using a 1-mm screen. Steers were switched between paddocks every week to reduce possible effects of forage availability. The orts in feeders were collected and weighted daily, and sampled twice a week to determine DM and CP. These data were used to determine DM and CP daily intake.

Samples were analyzed for dry matter (DM), crude protein (CP) and organic matter (OM) according to AOAC (1994), and for neutral detergent fiber (NDF) (VAN SOEST et al., 1991). *In vitro* dry matter digestibility (IVDMD) was conducted using Tilley and Terry (1963). The procedure was run in a batch fermentation vessel DAYSI[II]/ANKON® (ANKON Technology Corp., Fairport, NY, USA). The IVDMD values were used to calculate the digestible organic matter (DOM) and the total digestible nutrients (TDN) using the equations of Kunkle and Bates (1998):

$$DOM = -0.664 + (1.032\,(IVDMD))$$

where:

DOM = digestible organic matter (%); IVDMD = *in vitro* dry matter digestibility (%).

$$TDN = (OM\,(26.8 + 0.595\,DOM)) / 100$$

where:

OM = organic matter (%); DOM = digestible organic matter (%).

Data were analyzed using the GLM procedure of SAS (2000), Release 8.1. Data on forage availability and forage characteristics (FM, GLB, SGS, DMT and GLB/SGS) were analyzed considering time of year (1, 2 and 3) as the independent variable using the model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

where:

Y_{ij} = dependent variable; μ = overall mean; T_i = effect of period of the year and e_{ij} = error effect.

Animal performance data were analyzed for the effect of treatments (protein supplements) using the model:

$$Y_{ijk} = \mu + T_i + e_{ijk}$$

where:

Y_{ijk} = dependent variable; μ = overall mean; T_i = treatment effect and e_{ijk} = error effect.

Averages were compared using Tukey test at 5% significance. P values between 0.05 and 0.10 were considered as showing a tendency.

Results and discussion

There was no influence of periods ($p > 0.05$) on forage mass (FM), stem + green sheath (SGS) and dead material (DMT) (Table 3). There was a tendency ($p = 0.087$) of decrease in green leaf blade (GLB), but GLB/SGS ratio remained similar across the periods.

Table 3. Forage mass (FM), green leaf blade (GLB), stem + green sheath (SGS), dead material (DMT) and GLB/SGS ratio of Mombaça grass pasture.

Variables	Period[1]			Average	SEM[2]	*P* value
	1	2	3			
FM (kg ha^{-1})	10679	9801	9727	10069	190.640	0.467
GLB (kg ha^{-1})	2610	2073	1903	2195	80.000	0.087
SGS (kg ha^{-1})	6559	6336	6225	6373	153.908	0.894
DMT (kg ha^{-1})	1510	1392	1599	1500	50.200	0.664
GLB/SGS	0.40	0.33	0.31	0.34	0.013	0.175

[1]Periods corresponded to 1= 7/25; 2= 8/22; and 3 = 9/19; [2]SEM = Standard Error of Mean.

During the dry season in Brazil, tropical pastures show a slow growth rate (CANTO et al., 2002) and consequently a decrease in FM is normal as a result of continuous or rotational grazing. In this experiment, the pasture was deferred and FM accumulated before experimental period. Pasture management should observe more than a minimum of FM availability to allow unconstrained DMI. The FM observed in this research was 10,069 kg ha^{-1} and provided more than 3 to 4 times intake (GIBB, 2006).

Under grazing, there is a close relationship between leaf proportion (O'DONOVAN; DELABY, 2005), green leaf mass (SMIT et al., 2005) and dry matter intake. Considering the FM and GLB observed in the present experiment, it can be assumed that steers were exposed to abundant forage and therefore had the opportunity to graze selectively. Regardless of period, GLB represented a substantial proportion of forage mass, which was higher than 19.5% (Table 3), and had high availability (> 1900 kg ha^{-1}) (Table 3).

Forage mass decreased by 952 kg from the first to the last evaluated period, especially as a result of a decrease in GLB that reduced to 707 kg ha^{-1}. Decrease in GLB was the result of animal preference, as also observed by Brâncio et al. (2003) with steers grazing three different *Panicum* cultivars, where animals showed high selectivity for green leaves (92.4%) and low selectivity for stems (6.7%).

The GLB/SGS ratio indicates forage quality and as it is higher the pasture offers the animals forage with better nutritive value. The mean GLB/SGS ratio (0.34) shown in Table 3 was lower for Mombaça grass than normally occurs in this period in Brazil (CÂNDIDO et al., 2005), and probably as a consequence of the high production of reproductive tillers and pasture height (96 cm). Cândido et al. (2005), evaluating Mombaça grass pasture and using 44 to 63 days of grazing interval, found a GLB/SGS ratio of 0.43 for a pasture height of 68.6 cm after grazing. Euclides et al. (2008) evaluated Mombaça grass under grazing, for four years and also verified a higher GLB/SGS ratio, which ranged from 0.39 to 0.43. The lower GLB/SGS ratio seen in our experiment probably did not limit intake because the pasture showed a high GLB (2,195 kg ha^{-1}) that could be give to the animals possibility of high selection.

Data for qualitative characteristics of Mombaça grass during different periods are shown in Table 4.

Table 4. Average contents of crude protein (CP) and neutral detergent fiber (NDF) and *in vitro* dry matter digestibility (DMIVD) of Mombaça grass.

Variables	Period[1] 1	2	3	Average	SEM[2]	*P* value
Forage mass (FM)						
CP (%)	7.24	6.80	6.58	6.87	0.069	0.053
NDF (%)	63.54	62.41	61.94	62.63	0.222	0.238
IVDMD (%)	49.76	48.99	50.65	49.80	0.260	0.358
Green leaf blade (GLB)						
CP (%)	14.41	12.31	12.59	12.77	0.119	0.060
NDF (%)	56.77[a]	55.97[ab]	54.49[b]	55.74	0.227	0.035
IVDMD (%)	58.19	56.78	59.88	58.28	0.322	0.059
Stem + green sheath (SGS)						
CP (%)	5.44	5.44	5.24	5.38	0.032	0.244
NDF (%)	64.72	63.40	63.08	63.73	0.222	0.193
IVDMD (%)	50.45	49.94	51.58	50.66	0.311	0.490
Dead material (DMT)						
CP (%)	4.52	4.50	4.52	4.51	0.024	0.984
NDF (%)	68.97	67.14	66.36	67.49	0.290	0.078
IVDMD (%)	32.67[b]	33.51[b]	36.21[a]	34.13	0.323	0.008

[ab]Values in the row with different superscripts means significant difference ($p < 0.05$) by Tukey test. [1]Periods corresponded to 1= 7/25, 2= 8/22 and 3 = 9/19; [2]SEM = Standard Error of Mean.

Crude protein in FM was highest in period 1 and lowest in period 3 ($p = 0.053$). Also, there was a tendency ($p = 0.06$) of CP in GLB to differ in the different periods. The IVDMD showed a tendency ($p = 0.059$) to increase from period 1 to period 3 in GLB, while NDF showed a tendency to decrease ($p = 0.078$). The NDF in GLB and IVDMD in DMT were both affected ($p < 0.05$) by period whereby the NDF in GLB showed the highest value (56.8%) in period 1 and the lowest (54.5%) in period 3.

Regardless of forage component and significance, Table 4 shows for all forage components, lower value of NDF in period 3 which is associated with the start of re-growth.

The results for IVDMD (49.8%) are lower than observed by Canto et al. (2002), who reported IVDMD of 53%, but this author managed pasture to maintain a lower height. Euclides et al. (2008) evaluated Mombaça grass under grazing for four years and verified a higher organic matter *in vitro* digestibility which ranged from 58.10% before grazing to 50.30 after grazing. Protein supplements had an associative effect in relation to the use of available forage in the pasture, causing changes in the digestibility and forage intake (MOORE et al., 1999).

Considering initial and final weight, the average live weight was 325.75 kg (Table 5), and supplement fed (0.4% LW), the intake of protein supplement was on average 1.30 kg day^{-1}, and crude protein intake ranged from 0.163 kg day^{-1} for 12.5% CP supplement to 0.650 kg day^{-1} for 50% CP supplement. In relation to LW protein intake ranged from 0.05 to 0.20%.

Moore et al. (1999) reviewed the effects of supplementation on cattle performance and reported that in terms of protein supplementation the best results can be obtained if protein is supplied over 0.05% of LW. This level was attained using supplement with 12.5% CP, and higher supplementation did not influence ($p > 0.05$) ADG (Table 5) which averaged 0.61 kg day^{-1}.

Using an average LW (average of initial and final weight) of 325.75 kg and based on NRC (2000), dietary CP should be near 8.5% for 0.6 kg of ADG. Daily gain obtained in this study was very close to 0.6 kg day^{-1}, showing that in this situation, intake of NE limited the ADG such that a 12.5% CP supplement was enough. At least 7% crude protein is necessary in the diet to sustain microbial growth and support efficient fibrous carbohydrate digestion of low-quality forages (LAZZARINI et al., 2009). Supplementation with nitrogen compounds in quantities that raise the crude protein content in the diet to levels close to 9% optimizes the use of low-quality forage by cattle under grazing (FIGUEIRAS et al., 2010).

Table 5. Initial and final live weight and average daily gain (ADG) of steers.

Variables	Treatments				Average	SEM[1]
	12.5%	25.0%	37.5%	50.0%		
Initial LW (kg)	303	301	297	300	300.25	4.565
Final LW (kg)	354	354	349	348	351.25	5.340
ADG (kg day^{-1})	0.610	0.634	0.616	0.568	0.607	0.028

[1]SEM = Standard Error of Mean.

The average daily gain observed in this experiment was higher than the gain reported by Zanetti et al. (2000) that also supplemented steers (207 kg LW) grazing *Brachiaria decumbens* with chopped sugar cane and protein supplement. These authors supplemented 10.5 kg day^{-1} of chopped sugar cane, and 0.65 kg of a supplement with 52.5% CP, and reported gain of 0.36 kg LW day^{-1}. Zanetti et al. (2000) supplied a total of 0.34 kg day^{-1} of crude protein, which should be enough for higher gains, but the low forage availability (< 3,000 kg ha^{-1}) may have compromised performance.

Using a protein supplement with 18% CP for steers grazing on *Brachiaria brizantha* cv. Marandu, fed at level of 1% LW, Canesin et al. (2007) verified a daily average gain of 0.51 to 0.57 kg day^{-1}. Gonçalves et al. (2007) supplemented steers grazing on native pasture with full fat rice bran at level of 0.5% LW and verified average daily gain of 0.55 kg day^{-1}. Both results are inferior to our supplementation, but these authors used more supplement in relation to LW.

Canto et al. (2002) working with Tanzania grass without grazing for 70 days, in the same region and in the same season of the year, supplemented steers only with salt plus urea as nitrogen source and obtained lower gains, between 135 and 195 kg ha^{-1}, as result of lower stocking rate (1.8 to 3.2 AU ha^{-1}). In our experiment, stocking rate ranged from 4.75 AU ha^{-1} (start) to 5.55 AU ha^{-1} (end) much higher than Canto et al. (2002), which give a gain of 364 kg ha^{-1}.

Conclusion

The use of protein supplement (with 12.5% CP, DM basis) at the rate of 0.4% of LW mixed with chopped sugar cane tops fed at the rate of 0.8% of LW for beef production in Mombaça pasture with high forage mass availability can produce steer gains of 0.6 kg of LW day^{-1} and 350 kg of LW ha^{-1} during the dry season (May to September).

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