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Supplementation levels for growing beef cattle grazing in the dry-rainy transition season[1]

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ABSTRACT - The objective of this experiment was to study the effects of different levels of supplementation on the performance, intake, digestibility, pH and rumen ammonia concentration in growing bulls grazing *Brachiaria decumbens* Stapf. pasture, during the dry-rainy transition season. For evaluation of performance, intake and digestibility, it was used 25 non-castrated steers at 11 months of age and initial average body weight of 270 kg, grouped in five plots of five animals each, following a completely randomized design. Each plot received one of the following feeding treatments: mineral mixture and supplement at the proportion of 0.5, 1.0, 1.5 and 2.0 kg/animal/day, corresponding to 0.18, 0.36, 0.54 and 0.72% of the average body weight of the animals. The area designated for the animals was constituted of five 2.0-ha paddocks. For the evaluation of the pH and rumen ammonia concentration, five crossbred non-castrated steers were used, with average body weight of 240 kg, fistulated in the esophagus, rumen and abomasum, disposed in a 5 × 5 Latin square, with five treatments and five experimental periods. Animal performance behaved in a positive linear manner according to the supplementation levels, responding with an increase of more than 80% on weight gains of the animals. Intakes of total and pasture dry matter (DM), organic matter and neutral detergent fiber were not influenced by supplementation. Intakes of crude protein, non-fibrous carbohydrates, ether extract and total digestible nutrients as well as nutrient digestibility and rumen ammonia concentration showed a positive linear pattern in response to supplementation levels. Increasing levels of concentrate supplementation influence positively the performance of bulls growing on pastures during the dry-rainy transition season.

Key Words: beef cattle, digestibility, intake, multiple supplements, Zebu cattle

Níveis de suplementação para recria de bovinos de corte em pastejo durante o período de transição seca-águas

RESUMO - Objetivou-se estudar os efeitos de diferentes níveis de suplementação sobre o desempenho, o consumo, a digestibilidade, o pH e a concentração de amônia ruminal em bovinos recriados em pastagem de *Brachiaria decumbens* Stapf. durante o período de transição seca-águas. Para avaliação do desempenho, do consumo e da digestibilidade, foram utilizados 25 novilhos não-castrados com idade e peso médio iniciais de 11 meses e 270 kg, divididos em cinco lotes de cinco animais, segundo um delineamento inteiramente casualizado. Cada lote recebeu um dos seguintes complementos alimentares: mistura mineral; e suplemento na proporção de 0,5; 1,0; 1,5 e 2,0 kg/animal/dia, correspondentes a 0,18; 0,36; 0,54 e 0,72% do peso corporal médio dos animais. A área destinada aos animais foi constituída de cinco piquetes de 2,0 ha. Para a avaliação do pH e da concentração ruminal de amônia, foram utilizados cinco novilhos mestiços não-castrados, com peso médio de 240 kg, fistulados no esôfago, rúmen e abomaso, dispostos em quadrado latino 5 × 5, com cinco tratamentos e cinco períodos experimentais. O desempenho dos animais comportou-se de forma linear positiva de acordo com os níveis de suplementação, refletindo em aumento de mais de 80% no ganho de peso dos animais. Os consumos de matéria seca (MS) total e do pasto, de matéria orgânica e de fibra em detergente neutro não foram influenciados pela suplementação. Os consumos de proteína bruta, carboidratos não fibrosos, extrato etéreo e nutrientes digestíveis totais, assim como a digestibilidade dos nutrientes e a concentração de amônia ruminal, apresentaram comportamento linear positivo em resposta aos níveis de suplementação. Níveis crescentes de suplementação concentrada influenciam positivamente o desempenho de bovinos recriados em pastejo no período de transição seca-águas.

Palavras-chave: consumo, digestibilidade, gado de corte, suplementos múltiplos, zebuínos

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Introduction

The Brazilian permanence in the meat international market depends, among many other aspects, on the constant and a constant offer of a product with quality. Because it is fundamental for establishing age of slaughter, growing phase plays an important role in this context inasmuch as younger animals present more protein deposition and softer meat (Magnabosco et al., 2006).

Supplementation at pasture, the best use of animal genetic potential through crossings and slaughter of males and females for meat production are solutions which guarantee offer of animals and profitability of the production systems.

However, it should be clearly defined the objective of supplementation in the productive system. Therefore, contribution of the nutrients via supplementation during growing can aim different levels of animal performance, from the simple maintenance to daily gains from 500 to 600 g, aiming at slaughter of the animals at 20 months of age (Paulino et al., 2001).

Positive effects on weight gain occur when protein intake is greater than 0.1% of body weight (BW) and they differ little among protein sources. Small effects on weight gain are observed when protein intake is low and they can be confused with effects of forage availability and type of supplement provided (Moore et al., 1999).

When evaluating levels of total digestible nutrients (TDN) similar for soybean and corn grains, Garces-Yepez et al. (1997) found similar gains with supplementation of approximately 0.5% BW, with increases of 10 to 25% in performance when 1.0% BW was supplemented. According to Kunkle et al. (2000), effects of supplementation with corn or soybean on intake and digestibility of forage are advantageous, especially in animals fed levels above 5% of the body weight.

Sales et al. (2008) added increasing levels of energy supplementation, setting the consumption of crude protein (CP) at 0.3 kg/day and found negative responses on animal performance. Although there was any effect on dry matter intake, levels of energy supplementation impaired pasture intake and fiber digestibility.

The objective of this work was to study the effects of different supplementation levels on productive performance, intake, digestibility, pH and rumen ammonia concentration on bovines growing on pasture during the dry-rainy transition season.

Material and Methods

The experiment was carried out in Setor de Bovinocultura de Corte at Universidade Federal de Viçosa from October 2005 to January 2006.

It was used 25 non-castrated Zebu steers at initial age of 11 months and weight of 261 kg, distributed into five plots of five animals following a complete random design. Each plot received one of the five supplementation levels: mineral mixture; and supplementation at the proportion of 0.5; 1.0; 1.5 and 2.0 kg/animal/day provided at different quantities and containing 37% of CP and 36% of neutral detergent fiber (NDF) (Table 1).

Table 1 - Supplement percentage composition based on natural matter and chemical composition of supplement and pasture

Ingredient	% in the supplement
Urea/anmonia sulphate (9:1)	3.00
Cottonseed meal	40.00
Wheat meal	57.00

	Quantity supplied via supplement (kg)			
	0.5	1.0	1.5	2.0
Crude protein	0.158	0.317	0.475	0.633
Total digestible nutrient [1]	0.281	0.562	0.843	1.124

Chemical composition

Item	Supplement	*B. decumbens* (esophageal extrusa)		
		October/November	November/December	December/January
Dry matter (%)	85.47	87.64	87.75	88.60
Organic matter (% OM)	94.03	89.29	90.20	88.45
Crude protein (% DM)	37.04	9.95	8.88	9.34
Neutral detergente fiber (%DM)	36.23	63.05	63.31	61.81
Ether extract (%DM)	2.65	1.02	1.02	0.99
Non-fibrous carbohydrates (%DM)	22.91	15.26	16.99	16.30
Total carbohydrates (%DM)	54.34	78.32	80.30	78.11
Lignine (%DM)	4.82	3.68	3.31	3.65
Acid detergent insoluble nitrogen (%total N)	2.24	26.13	28.27	27.63
Neutral detergent insoluble nitrogen (% total N)	7.22	51.92	52.82	48.36

[1] Calculated according to NRC (2001).

Mineral mix, which was composed of 47.15% sodium chloride (NaCl), 50% of dicalcium phosphate, 1.5% zinc sulphate; 0.75% copper sulphate; 0.05% cobalt sulphate; 0.05% potassium iodate and 0.5% magnesium sulfate, was freely given for all the animals.

The experimental area for the animals was constituted of five 2.0-ha paddocks, formed with *Brachiaria decumbens* Stapf. and provided with covered drinkers and troughs. Aiming at reducing influence of variation on pasture dry matter availability, rotations of animals among paddocks was performed at every seven days.

For determination of total dry matter availability, pasture collection was performed on the first day of each experimental period by cuts close to the soil in five areas, randomly selected in each experimental paddock, delimited by a 0.25-m^2 metal square

At collection, samples were divided into two parts: one part was weighted and immediately oven-dried at 55°C for 72 hours, for determination of total availability of pasture dry matter; the other sample was sorted in green leaves, dry leaves, green stems and dry stems for determination of structural components. Availability of potentially digestible dry matter (pdDM) was estimated by the following equations:

$$pdDM (\%) = 0.98 \times (100 - NDF) + (NDF + iNDF)$$

in which: NDF = neutral detergent insoluble fiber; iNDF = indigestible NDF.

All animals were submitted to digestion trial on the pasture, for a period of ten days so the seven initial days were for adaptation of the animals and stabilization of flow of markers as described by Titgemeyer et al. (2001).

To evaluate chemical composition of forage consumed by the animals, it was used esophagus fistulated animals which, after a 16-hour food and water fast, were conducted to experimental paddocks for esophageal extrusa collection. These were performed at 7: a.m. on the fifth day of the digestion trial by using screen-bottom collection bags fitted around esophageal fistula. After 40 minutes of grazing, bags were removed and samples were weighed.

To estimate fecal dry matter excretion (FE), chromium oxide was used as external marker according to recommendations by Smith & Reid (1955), and it was applied in a single daily dose (10 g/animal) packed in a paper cartridge and introduced directly in the esophagus of the animals with the help of an applicator for nine consecutive days. After seven days of adaptation, samples of feces were collected on the eighth, (4:00 p.m.), ninth (12 p.m.), and tenth (8 a.m.) days. Calculations of fecal excretion were done based on the ratio between quantities of supplied marker to its concentration in the feces, according to the equation:

$$FE (g/day) = (Supplied\ Cr / Fecal\ Cr) \times 100$$

in which: supplied Cr = chromium quantity (g) and fecal Cr = concentration of marker in feces (%).

Dry matter voluntary intake (DMI) was estimated by using indigestible ADF (iADF) as internal marker obtained after 264 hours of *in situ* incubation (Casali et al., 2008), by the equation:

$$DMI (kg/day) = \{[FE \times fecal\ iADF) - supplement\ iADF] \div forage\ iADF\} + SDMI$$

in which: fecal iADF = iADF in the faeces (%); supplement iADF= iADF in the supplement (kg/day);forage iADF= iADF in the forage (kg/kg) and SDMI = supplement dry matter intake (kg/day).

For determination of individual consumption of supplement (ICS), titanium dioxide was used at the average quantity of 10g/animal, mixed to the supplement immediately before supply, according to procedure described by Valadares Filho et al. (2006), following the same scheme of fecal collection for chromium oxide, through the equation:

$$ICS (g/day) = (FE \times feces\ TiO) \div supplement\ TiO$$

In which TiOFeces and TiO supplement are the titanium dioxide concentration in the feces and in the supplement, respectively.

After collection, samples of extrusa and feces were oven-dried at 55°C for 72 hours , processed in a Willey mill (1.0 mm) and afterwards submitted to laboratory analyses according to techniques described by Silva & Queiroz (2002) except for determination of NDF and ADF, which followed methods described by Mertens (2002) and Van Soest & Robertson (1985), respectively.

From dry matter intakes and fecal excretions, it was possible to calculate digestibility of nutrients and to estimate intake and contend of dietary TDN.

To evaluate the effect of supplements on pH and ruminal ammonia concentration, it was used five Holstein × Zebu crossbred non-castrated steers with initial average weight of 240 kg, fistulated in the rumen and abomasum (Leão et al., 1978).

The experimental area for fistulated steers was constituted of five 0.4-ha paddocks, uniformly covered with *Brachiaria decumbens* Stapf. provided with covered drinkers and feeders.

The fistulated animals were organized in a 5 × 5 Latin square design with five supplementation levels and five 14-day experimental periods.

Because of the great weight difference among fistulated animals, it was chosen to supply supplements based on percentage of body weight of the animals. So, quantities corresponding to treatments of the performance experiment were divided by average weight of animals in each treatment, calculating the offer in % of BW of the animals in the performance experiment. The values were applied on the fistulated animals.

On the 14th day of the experimental period, samples of the ruminal fluid were collected in the region of liquid/solid interface of ruminal environment before and four hours after supplement supply to determine pH and ammonia concentration. Afterwards, those samples were filtered through a gaze triple layer. Analyses of pH were done immediately after collection by using a digital pH meter. For determination of ammonia, it was used a 50-mL sample added with 1.0 mL of H_2SO_4 1:1, placed in a plastic container with a cover, identified and frozen. Concentrations of N ammoniac were obtained after distillation with KOH 2N, according to technique described by Fenner, in 1965, adapted by Vieira (1980). Blood samples were collected by puncture of jugular vein by using test tubes with anticoagulant on the 14th day of the experimental period. After that, serum samples were taken, which were wrapped and frozen at -15°C for further urea analyses. At the end of the experiment, serum was thawed at room temperature and analyzed for urea determination, following the modified diacetyl method using picrate and acidifier, both using commercial kits.

All results were analyzed by regression analysis at 10% of significance.

Results and Discussion

It was observed an average total dry matter content (TDM) of 4,613 kg/ha. As plant grew older, the effect of animal load and the approach of the rainy season, when there was greater forage availability, associated with an increase on green leaf quantity (Table 2), with a reduction of dry leaves. Similarly, percentage of dry culms was reduced, and markedly replaced by green culms. This result was expected because of the increase of rainfall and acceleration of growth rate of the grasses in this season.

However, total dry matter remained greater than those indicated as limiting to animal selectivity, 4,262 kg/ha (Euclides et al., 1992) and 2,000 kg/ha (Minson, 1990). This might have enabled increase on pasture dry matter intake during the experiment.

Tropical forage species present great production potential. However, dry matter accumulation over plant growth is followed by thickness and increase on lignification of the cell wall, in addition to a reduction on leaf:stem ratio, therefore compromising its quality as food for ruminants (Minson, 1990).

Therefore, it is inferred that besides forage chemical traits, production of bovines on pasture also depends on structural and phenological traits of the plant, as for example height, vegetal biomass density (kg/ha.cm^{-1}), leaf:stem ratio, inflorescence proportion and dead material. Those pasture structural traits determine selection degree on grazing by bovines, as well as how efficiently animal harvest forage on the pasture, affecting quantity of ingested nutrients.

The average content of crude protein of extrusa (Table 1) during the experimental period was 9.39% in DM, greater than the 7% considered by Lazzarini et al. (2009) as the limiting value in order to rumen microorganisms show complete capacity of using basal forage fiber carbohydrates (Mathis et al., 2002). However, 51% of this total is found as neutral detergent insoluble protein (NDIP) with slow and incomplete degradation which reinforces the importance of additional supply of more rapidly available nitrogen sources.

The productive performance, evaluated by average daily gain, was linearly positive to supplementation levels (Table 3), and an increase of more than 80% on performance of the highest supplementation level animals was observed, when compared to animals which were not given supplement. This can be explained by the increase on intake of TDN and metabolizable energy on animals at the highest supplementation level (Table 4), evidencing that animals in

Table 2 - Forage availability and leaf:stem ratio in the different experimental periods

Item	Period			Means
	October/November	November/December	December/January	
Total dry matter (kg/ha)	4,582.53	4,581.64	4,674.96	4,613.04
Green leaf dry matter (kg)	965.13	962.63	1,167.46	1,031.74
Green leaf dry matter (%)	21.06	21.01	24.97	22.35
Dry leaf dry matter (kg)	1,102.36	862.73	594.26	853.12
Dry leaf dry matter (%)	24.06	18.83	12.71	18.53
Green stem dry matter (kg)	1,309.05	966.52	1,900.08	1,391.88
Green stem dry matter (%)	28.58	21.10	40.64	30.11
Dry stem dry mater (kg)	1,205.99	1,789.76	1,013.16	1,336.30
Dry stem dry matter (%)	26.32	39.06	21.67	29.02
Leaf:stem	0.82	0.66	0.60	0.69

the growth phase respond very efficiently to the input of nutrients. According to Berg & Butterfield (1976), after birth, through proper management and feeding, bovines grow according to a sigmoidal curve, more intensively during the growing phase, reducing as they approach the adult phase. Because of this, when using growth potential of this phase at matter, the response will be the decrease in the productivity cycle of beef livestock, and consequently, increase on the profit. Pastures are the most economical and feasible manner of feeding bovines. Therefore, increasing the use of forage through optimization of intake and availability of its nutrients become a priority.

By analyzing additional average daily gain, which represents increase in weight gain provided by the supplements, it is observed that there was an increment of 317g/day on animal performance at the highest supplementation level in comparison to the non-supplemented animals.

Those additional gains obtained in this phase might cause slaughter of the animals before the second drought,

Table 3 - Animal performance and serum urea levels for different supplementation levels

Item	Suplementation level (kg)					CV (%)	P-value[1,2]	
	0.0	0.5	1.0	1.5	2.0		Linear	Quadratic
Average daily gain (kg/day)[3]	0.371	0.526	0.563	0.617	0.694	23.1	***	ns
Initial body weight (kg)	257.80	284.00	273.50	272.25	266.25			
Final body weight (kg)[4]	291.90	332.38	325.25	329.00	330.13	3.6	***	ns
Total weight gain (kg)	34.10	48.37	51.75	56.75	63.87			
Aditional daily gain (kg)	-	0.155	0.192	0.246	0.324			
Seric urea (mg/dL)[5]	9.82	16.98	19.15	19.87	21.13	5.1	***	ns

CV = coeficiente of variation.
[1] L and Q = effects of linear and quadratic order in function of the supplementation levels.
[2] ns - P>0.10 and *** P≤ 0.01.
[3] $\hat{Y} = 0.4019 + 0.1507X$ ($r^2 = 0.9645$).
[4] $\hat{Y} = 305.1304 + 15.9380X$ ($r^2 = 0.9645$).
[5] $\hat{Y} = 12.2892 + 5.1032X$ ($r^2 = 0.8021$).

Table 4 - Dry matter and nutrient intakes and substitution coefficient according to the supplementation levels

Item	Suplementation level (kg)					CV (%)	P-value[1,2]	
	0.0	0.5	1.0	1.5	2.0		L	Q
			kg/day					
Total dry matter	4.809	5.388	5.752	5.772	5.824	24.6	ns	ns
Pasture dry matter	4.809	4.982	4.912	4.571	4.188	24.9	ns	ns
Supplement dry matter		0.406	0.840	1.201	1.636			
Total organic matter	4.338	4.875	5.220	5.252	5.316	24.6	ns	ns
Pasture dry matter	4.338	4.493	4.431	4.123	3.778	24.9	ns	ns
Crude protein[3]	0.427	0.593	0.747	0.851	0.978	26.2	***	ns
Neutral detergente fiber (NDF)	2.916	3.168	3.282	3.206	3.132	24.6	ns	ns
Pasture NDF	2.916	3.021	2.978	2.771	2.539	24.9	ns	ns
Non-fibrous carbohydrates[4]	0.817	0.939	1.027	1.052	1.086	24.7	*	ns
Ether extract[5]	0.062	0.075	0.086	0.091	0.097	24.9	***	ns
Total digestible nutrients[6]	3.021	3.449	3.841	3.886	4.010	24.2	*	ns
Substitution coefficient		–0.40	-0.12	0.18	0.36			
			g/kg BW					
Dry matter	18.40	19.00	21.00	19.60	20.82	16,9	ns	ns
Pasture dry matter[7]	18.40	17.62	17.98	15.54	14.96	18,5	*	ns
Organic matter	16.59	17.19	19.04	17.84	18.99	16,9	ns	ns
Pasture dry matter[8]	16.59	15.89	16.23	14.01	13.50	18,4	*	ns
Neutral detergente fiber	11.15	11.18	11.99	10.89	11.19	17.4	ns	ns
Pasture NDF[9]	11.15	10.68	10.91	9.42	9.07	18.4	*	ns

CV = coefficient of variation.
[1] L and Q = linear and quadratic effects of supplementation levels.
[2] ns – P>0.10; * 0.05>P≤0.10 and *** Pd≤0.01.
[3] $\hat{Y} = 0.4470 + 0.2721X$ (r^2=0.9921).
[4] $\hat{Y} = 0.8537 + 0.1304X$ (r^2=0.9073).
[5] $\hat{Y} = 0.0649 + 0.0173X$ (r^2=0.9737).
[6] $\hat{Y} = 3.1582 + 0.4833X$ (r^2=0.8876).
[7] $\hat{Y} = 1.8692 – 0.1792X$ (r^2=0.8406).
[8] $\hat{Y} = 1.6857 – 0.1613X$ (r^2=0.6300).
[9] $\hat{Y} = 1.1332 – 0.1085X$ (r^2=0.8379).

that is, before 20 months of age, which besides of leading to a faster turnover of the capital makes management on the farm easier and reduces cost with further implementations on either confinement or semi-confinement on pasture, because this is the phase of the highest feed efficiency of the animals and greater economic and productive return of the supplementation.

According to Leng (1990), use efficiency of metabolizable energy (ME) of the forage can be significantly improved by supplementation. When deficiencies of the nutrients are reduced, supplementation ensures efficient microbial growth, which can result in efficient microbial fermentation with a maximal extraction of forage carbohydrates, with a consequent increase on the production of volatile fatty acids. Besides, the increase on microbial synthesis, provided by dietary crude protein, rises exit of microbial protein in the rumen.

Paulino et al. (2005), when evaluating the effect of different energy sources in multiple supplements on productive performance of steers growing on pasture in the rainy season, reported that, although there had not been difference on average daily gain among the supplementation levels, the supplement containing ground ear corn (GEC) provided additional gains at the order of 220g/day when compared to control treatment, which was mineral mixture, only. Average weight gain for all supplements was 1.247 kg/day, which is greater than the values found in the present study. According to these authors, those additional gains may be associated to the elimination of negative associative effects among forage and grains, provided by the total meeting of requirements of protein degraded in the rumen.

Villela et al. (2008) found statistical differences for weight gain of the animals when evaluated supplements formulated with different protein sources for steer growing in the dry-rainy transition season. Additional weight gains of 223 g/day were observed for the animals that were fed supplement with cottonseed meal as protein source in comparison to the animals that only received mineral mixture.

The total intakes of dry matter, organic matter and NDF as well as the intakes of these nutrients just from the pasture were not influenced by the supplementation levels. Intakes of crude protein, non-fiber carbohydrates, ether extract and total digestible nutrients showed linear positive behavior in function of supplementation levels (Table 4). Because contents of those nutrients are relatively low in the basal forage, additional supply of concentrated sources resulted in a significant increase of its ingestion.

Substitution coefficient (SC) is the relationship among forage dry matter quantity, which was no longer consumed, and the quantity of ingested supplement (Reis et al., 1996). In this work, the SC ranged from –0.40 to 0.36 (Table 6). If decrease on forage intake is equal to quantity of concentrated consumed, SC will be 1.0 and supplement will have little effect on production. On the contrary, if supplement has no effect on forage intake, substitution coefficient will be equal to zero and it will be observed a full benefit of its use. However, if this coefficient is negative, there will be a characterization of additive effect, with the supplement stimulating forage intake.

Intake of neutral detergent fiber was not influenced by supplementation levels probably because of the high content of this component in the supplement, around 36%, a value which was influenced mainly by the presence of cottonseed and wheat meal, with 31 and 42% of NDF, respectively. Because fiber of meals are more digestible, digestibility coefficient of this component increased without influencing ingestion of dry matter inasmuch as the highest influence on this characteristic is exercised by pasture NDF. The same logic can be applied for the other nutrients.

Effects of supplementation on dry matter, organic matter and neutral detergent fiber were not observed although it had been observed significant improves on digestibility of these dietary components (Table 5).

Digestibility of all nutrients was linearly and positively affected by supplementation levels (Table 5), showing improvement on rumen environment and greater microbial activity, especially because of the associative effects among nutrients.

It was not observed significant effects of supplementation levels on ruminal pH before or after four hours of supplement supply (Table 6). However, at the highest level of supplementation, pH values were closer to the minimal limit considered proper (6.20) to cellulosic microorganisms (ϕrskov, 1982; Mould et al., 1983). There was no deleterious effect on fiber digestibility inasmuch as it increased as supplementation levels increased (Table 5).

Ruminal ammonia concentration (RAC) showed linear increase in function of supplementation levels, certainly because of the increase in protein intake by supplements and mainly because of the increase in ingested quantity of urea, whose hydrolyses rate is higher. Supply of supplement with higher degradability with readily available nitrogen source via vegetal ingredients or urea is responsible for the greatest concentrations of ruminal ammonia.

Ruminal concentration of ammonia nitrogen has been frequently used as reference for qualification of ruminal conditions for microbial activities, especially for microorganisms which degrade fiber carbohydrates and use ammonia as preferred nitrogen source for growth

(Russell et al., 1992). Ruminal ammonia concentration has to be in appropriate conditions for optimization of microbial growth and further use of fiber substrate on the forage.

Levels of ruminal ammonia are important inasmuch as microbial growth is highly dependent on quantity of ammonia and organic matter fermentation in the rumen (Bryant & Robinson, 1962, cited by Shain et al., 1998). It is observed that the levels obtained are above 5.0 mg/dL of ruminal fluid suggested by Satter & Slyter (1974) and Griswold et al. (2003) as non-limiting to microbial fermentation. However, the value found for non-supplemented animals are below 10.0 mg/dL of ruminal liquid considered by Leng (1990) as optimal for proper fermentation in tropical conditions.

For all the treatments, the values observed for RAC were below 20.0 mg/dL recommended by Mehrez et al. (1977) and Leng (1990) as the ideal for maximization of fermentation rate.

Table 5 - Total apparent digestibility of nutrients and dietary TDN in function of supplementation levels

Item	Suplementation level (kg)					CV (%)	P-value[1,2]	
	0.0	0.5	1.0	1.5	2.0		L	Q
Dry matter[3]	65.80	65.98	69.07	68.86	69.40	2.1	***	ns
Organic matter[4]	70.22	70.81	72.53	72.20	73.13	1.9	***	ns
Crude protein[5]	59.81	66.38	67.44	70.55	71.95	2.1	***	ns
Ether extract[6]	72.00	72.97	73.80	74.49	75.20	0.4	***	ns
Neutral detergent fiber[7]	71.72	73.11	74.55	73.25	74.89	2.1	***	ns
Non-fibrous carbohydrates[8]	70.97	67.11	72.36	74.15	73.76	4.8	**	ns
Total digestible nutrients[9]	62.82	64.01	66.78	67.33	68.85	2.0	***	ns

CV = coefficient of variation.
[1] L and Q = linear and quadratic effect of supplementation levels.
[2] ns – P>0.10; ** 0.01<P≤0.05 and *** Pd≤0.01.
[3] $\hat{Y} = 65.8044+2.0152X$ (r^2=0.8080).
[4] $\hat{Y} = 70.3368+1.4416X$ (r^2=0.8755).
[5] $\hat{Y} = 61.5312+5.6948X$ (r^2=0.9079).
[6] $\hat{Y} = 72.1068+1.5836X$ (r^2=0.9947).
[7] $\hat{Y} = 72.2080+1.2968X$ (r^2=0.6553).
[8] $\hat{Y} = 69.1424+2.5240X$ (r^2=0.8154).
[9] $\hat{Y} = 62.9856+3.0504X$ (r^2 =0.9662).

Table 6 - pH and ruminal ammonia concentration immediately before or four hours after supplemented offer

Time	Suplementation level (kg)					CV (%)	P-value[1,2]	
	0.0	0.5	1.0	1.5	2.0		L	Q
			Ruminal pH					
Before	6.54	6.40	6.41	6.56	6.21	3.2	ns	ns
4 hours after	6.51	6.46	6.38	6.39	6.15	3.2	ns	ns
			Ruminal ammonia (mg/dL of ruminal fluid)					
Before[3]	8.33	10.33	11.91	12.66	14.66	9.1	***	ns
4 hours after[4]	7.00	9.24	11.24	13.99	15.91	12.3	***	ns

CV = coefficient of variation.
[1] L and Q = linear and quadratic effects of supplementation levels.
[2] ns – P>0.10 and *** P≤0.01.
[3] $\hat{Y} = 8.2790+1.4988X$ (r^2=0.9635).
[4] $\hat{Y} = 3.6078+2.2572X$ (r^2=0.9958).

Conclusions

The offer of increasing levels of concentrated supplementation improves productive performance of beef cattle growing on pasture during dry-rainy transition season. Dry matter intake is not influenced by concentrated supplementation up to the level of 2 kg/day. Increase on supplementation level, however, has a linear effect on nutrient digestibility. Levels of rumen ammonia are linear and positively influenced by the increase on inclusion of urea in the diet.

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