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ORIGINAL RESEARCH

Strategies of supplementation of female suckling calves and nutrition parameters of beef cows on tropical pasture

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Abstract The performance of female calves in creep feeding under different strategies of supplementation and milk production, intake, and digestibility of grazing Nellore and crossbred cows (Nellore×Holstein) during the dry-rainy transition season were assessed. Forty-four female beef suckling calves, with initial age between 90 and 150 days and average initial body weight of 117.7±4.3 kg, and their respective dams (24 Nellore and 20 crossbred) with average initial body weight of 417.5±8.3 kg, were used. The experimental treatments consisted of: control group—mineral mixture only; strategy 1—supplementation from 112 days prior to weaning (0.375 kg/animal/day); strategy 2—supplementation from 112 days prior to weaning, in increasing amounts of 0.15, 0.30, 0.45, and 0.60 kg/animal/day through the four experimental periods, respectively; and strategy 3—supplementation from 56 days prior to weaning (0.750 kg/animal/day). Calves from strategy 1 had greater ($P<0.05$) average daily gain (0.672 kg/day) than control animals (0.582 kg/day) and greater ($P<0.05$) efficiency of supplement use than the other groups. Crossbred cows produced more milk than Nellore cows ($P<0.05$). Crossbred cows presented greater ($P<0.05$) dry matter intake (DMI) than Nellore cows. However, no differences were found ($P>0.05$) for nutrient digestibility among genetic types. It can be concluded that strategies of supplementation that present an equitable distribution of supplement provides greater weight gain in suckling female beef calves. Crossbred cows produce more milk and present greater DMI than Nellore cows. There are no differences in the nutrient digestibility between Nellore and Nellore × Holstein crossbred cows.

Keywords Creep feeding · Digestibility · Nellore · Intake · Performance

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Introduction

For the success in a beef cattle system, informations regarding animal's intake and nutrient digestibility are crucial. However, there is a lack of information regarding nutritional parameters of grazing beef cows of different genetic types. The use of crossbred cattle (*Bos taurus vs. Bos indicus*) is commonly seen in Brazil due to their better adaptability to the tropical environment (Souza et al. 2008). Feed intake as a function of body weight is greater in *B. taurus* cattle compared to *B. indicus* (Rubiano et al. 2009; Marcondes et al. 2011). Nonetheless, it has been reported that *B. indicus* cattle presents a greater capacity to deposit energy than crossbred cattle (*B. taurus vs. B. indicus*) (Sant'Ana et al. 2011).

Supplementation of grazing cattle increases the efficiency of nutrient utilization due to the batter utilization of basal nutritional sources (Paulino et al. 2006). In addition, although the pastures has a great nutritional values during the transition of rainy to dry season, the animal performance can be improved by protein supplementation (Sales et al. 2008).

For grazing cattle system that has an adoption of production technologies in order to reduce the age at the first conception, the use of strategies to improve the female calves' weight gain even during the suckling period is also important. In this context, the use of creep feeding seems to be an available tool to increase cattle weight at weaning and consequently reduce the raising period (Paulino 1999).

After 3 months of age, calves may already present a functional ruminant digestive system (Huber 1969) being able for a consumption of solid and fibrous feedstuff (Henriques et al. 2011). At the same time, there is a decrease of dam milk production being not enough to meet calves nutrient requirements (Silva 2000; Henriques et al. 2011). Moreover, it usually occurs during the transition of rainy to dry season, in most part of Brazil (tropical climate), which is in turn, the period when there is a reduction of quantity and quality of forage. Thus, a strategic supplementation of the calves at this period would optimize the animal efficiency and consequently improve their performance.

In this context, the objective of this study was to evaluate the effects of strategies of supplementation on performance of grazing female calves. A secondary objective was to evaluate intake, nutrient digestibility, and milk production of grazing Nellore and crossbreed cows (*B. indicus*×*B. taurus*) during the transition of rainy to dry season.

Materials and methods

All procedures involving animals were approved by Brazilian committee for care and experimentation.

Animals, experiment design, and diets

This experiment was conducted at the beef cattle facility of the Federal University of Viçosa, in Viçosa, MG, Brazil (20° 45′ S, 42°52′ W). The experimental area is located in a hilly area with 670 m of altitude and presents an average precipitation of 1,300 mm annually.

This study was carried out during the transition of the rainy to dry season, between March and June of 2008. Throughout the days of measurement, average minimum and maximum temperatures were 18.6 and 28.1 °C in March, 17.8 and 27.8 °C in April, 13.0 and 25.3 °C in May, and 12.7 and 23.6 °C in June, respectively. There were 228 mm of rain in March, 50 mm in April, 18 mm in June, and none in May.

Forty-four suckling beef calves with an average initial body weight of 117.7±4.3 kg and age between 90 and 150 days, and their respective dams (24 Nellore, 12 ½Nellore×½Holsteins, and eight $^3/_4$Nellore×$^1/_4$Holsteins) with average initial body weight of 417.5±8.3 kg and body condition score of 3.82±0.07 (scale ranging from 1 to 9), were used. Only Nellore sires were used in this study.

Animals were submitted to a period of 14 days of adaptation and a 112-day experimental period (four periods of 28 days each) for evaluation of performance. These animals were allocated in four groups. Each group was housed in a 7 ha plot of *Brachiaria decumbens* Stapf. provided with drinkers and feeders covered with asbestos tiles and privative feeders for calves. Each group of cattle was randomly assigned in one of the four experimental treatments: control —mineral mixture only; strategy 1—supplement provided from 112 days prior to weaning, (0.375 kg/animal/day); strategy 2—supplement provided from 112 days prior to weaning, in increasing amounts of 0.15, 0.30, 0.45, and 0.60 kg/animal/day through the four experimental periods, respectively; and strategy 3—supplement provided from 56 days prior to weaning (0.750 kg/animal/day).

It should be noted that at the end of the experiment all the animals received the same amount of supplement, varying only the offer strategy between treatments. With the exception of the control group which received only mineral mixture (calcium: 8.7 %; phosphorus: 8.5 %; sulfur: 9.0 %; sodium: 18.7 %; zinc: 2,400.00 mg/kg; copper: 800.00 mg/kg; manganese: 1,600.00 mg/kg; iodine: 40.00 mg/kg; cobalt: 8.00 mg/kg; selenium: 8.16 mg/kg), all the animals received the same type of supplement (60 % soybean meal and 40 % corn meal). Supplement compositions are presented in Table 1.

Calves were fed once a day at 10 a.m. The mineral mixture provided to the supplemented animals was added to the supplement and adjusted at every experimental period

Table 1 Chemical composition of supplement and forage

Item (% DM)	Supplement	Forage[a]	
		Calves[b]	Cows[c]
Dry matter	89.09	31.16±2.51	32.60
Organic matter	95.92	92.42±0.22	92.42
Crude protein	32.75	10.27±0.99	8.79
NDIN[d]	6.15	32.63±1.47	31.33
ADIN[e]	3.43	5.99±0.22	6.28
Ether extract	2.91	2.83±0.11	2.68
NDFap[f]	11.29	64.28±1.11	67.21
NFC[g]	48.97	15.05±0.79	13.75
ADFap[h]	4.26	26.50±1.14	28.97
iNDF[i]	1.25	20.56±1.59	24.19
Lignina	1.72	6.04±0.31	6.42

[a] Obtained by manual simulation of grazing
[b] average of the whole experimental period
[c] obtained at the intake Trial
[d] Neutral detergent insoluble nitrogen as % of total nitrogen
[e] Acid detergent insoluble nitrogen as % of total nitrogen
[f] Neutral detergent fiber corrected for ash and protein
[g] Non-fiber carbohydrate
[h] Acid detergent fiber corrected for ash and protein
[i] Indigestible neutral detergent fiber.

based on the intake of mineral mixture of the animals from the control group. Cows were fed with mineral mixture ad libitum and received 100 g/day of corn meal in feeders located paralleled to the creep feeding in order to allow the calves spend more time for supplement consumption.

In order to minimize possible effects of plots on experimental treatments, animals were rotated among the four pasture plots every 7 days, allowing each group to stay the same period of time in each plot.

The variation of body condition score (BCS) of the cows was determined by the difference between scores obtained at the beginning and at the end of the experimental period. A scale ranging from 1 to 9 points was used as recommended by NRC (1996), and the evaluation was made by the same three trained evaluators in all evaluations.

Experimental procedures and sampling

On day 14 of each experimental period, forage samples was randomly taken in order to evaluate the availability of total dry matter and potentially digestible dry matter (PDDM) per hectare. In each plot, four forage samples were randomly selected using a metal square (0.5×0.5 m) and cut at approximately 1 cm above the soil. After that, forage subsamples (200 g) were dried at 60 °C for 72 h and ground to pass through a 1-mm screen and kept at a room temperature for subsequent analysis.

On day 1, 14, and 28 of each experimental period, a manual simulation of grazing was performed simultaneously to the observation of grazing behavior of the animals in order to obtain samples to evaluate chemical composition of the forage consumed by the animals. All samples were dried at 60 °C for 72 h, grounded to pass through 1-mm screen, and proportionally sub-sampled to a composite sample.

In order to evaluate the forage intake and digestibility by the cows, digestion trial was performed simultaneously to the evaluation of calves' performance between day 55 and 60 of the experimental period. Fecal dry matter excretion was determined using purified and enriched lignin (LIPE®) as external marker following recommendations of Rodríguez et al. (2006). The animals received the marker once daily at 11 a.m., during 5 days of the digestion trial, by an applicator directly to the esophagus. After 3 days of adaptation, feces samples were collected at 3 p.m. on day 4, at 11 a.m. on day 5, and at 7 a.m. on day 6 of digestion trial period. Samples of feces from each animal in each day of collection were individually used to determinate the concentrations of LIPE®. The remaining feces samples were dried at 60 °C, grounded to pass through 1-mm screen, and proportionally sub-sampled to a composite sample. At day 3 of the digestion trial, a manual simulation of grazing was performed in each experimental plot and a sample was taken to estimate dry matter intake and digestibility of the pasture.

To estimate the milk production of the cows, milk samples were obtained at day 28 and 84 of the experimental period. Cows were separated from their calves at 6 p.m. At 6 a.m. of the next day, cows were milked immediately after an injection of 2 mL of oxytocin (10 IU/mL; Ocitovet®, Brazil) in the mammary gland and the produced milk was weighed within 2 h of from the beginning and the end of milking. The exact time that each cow was milked were recorded, and the milk production was converted to a 24-h production.

Chemical analysis

Samples of forage, feces, and supplement ingredients were analyzed for dry matter (DM), nitrogen compounds (N), ashes and ether extract (EE), AOAC (Association of Official Analytical Chemists-AOAC 1990). Lignin contend was obtained by cellulose solubilization with sulfuric acid (Van Soest and Robertson 1985). For analysis of neutral detergent fiber (NDF), samples were treated with alpha thermostable amylase without sodium sulfite and corrected for ash residue (Mertens 2002) and residual nitrogen compounds (Licitra et al. 1996). Acid detergent fiber analysis was performed as described by Van Soest and Robertson (1985) and corrected for ashes and nitrogen compounds as previously described. Indigestible neutral detergent fiber (NDFi) was analyzed as described by Casali et al. (2008) and non-protein nitrogen was determined according to Licitra et al. (1996). The non-fiber carbohydrate content, corrected for ash and protein (NFCap), was calculated as the following equation: $\mathrm{NFCap} = 100 - [(\%\mathrm{CP} - \%\mathrm{CP\ from\ urea} + \%\quad \mathrm{of\ urea}) + \%\mathrm{NDFap} + \%\mathrm{EE} + \%\ \mathrm{ash}]$ (Detmann and Valadares Filho 2010).

Forage samples obtained to evaluate the DM availability per hectare were analyzed for DM, ashes, NDF, and NDFi, as described above.

The estimative of the PDDM was obtained using the equation recommended by Paulino et al. (2006):

$$\mathrm{PDDM} = 0.98 \times (100 - \%\ \mathrm{NDF}) + (\%\ \mathrm{NDF} - \%\ \mathrm{NDFi}),$$

where 0.98 is the coefficient of intracellular content digestibility.

The voluntary DMI was estimated by using the NDFi as an internal marker and calculated by the following equation:

$$\mathrm{DMI\ (kg/day)} = [(\mathrm{FE} \times \mathrm{NDFi\ feces}) \div \mathrm{NDFi\ forage}],$$

where FE is the fecal excretion (kg/day); NDFi feces is the concentration of NDFi in feces (kg/kg); and NDFi forage is the concentration of NDFi in forage (kg/kg).

The efficiency of supplement use (ESU) was calculated as the following equation:

$$\text{ESU (kg of BW/kg of supplement)} = [(\text{BWG}_{\text{SA}} - \text{BWG}_{\text{CA}}) \div \text{SI}]$$

where, BWG_{SA} is the body weight gain of supplemented animals; BWG_{CA} is the body weight gain of control animals; and SI is the supplement intake.

Statistical analysis

The study with the calves was conducted under a completely randomized design and initial BW of the calves was used as covariate.

Additionally, the study with the cows was conducted under a completely randomized design using a 2×4 factorial arrangement (two genetic types of cows and four dietary treatments for calves). The initial BW and BCS of the BW were used as covariate for the cow's data analysis.

The data were analyzed using the GLM procedure of SAS version 9.1, (SAS Institute, Inc). Means were compared using Fisher's least significant difference test considered at $P<0.05$.

Results

The availability of forage DM and PDDM through the experimental period was 4.20 and 2.9 ton/ha, respectively.

The forage sampled by a manual simulation of grazing was considered as high quality forage, presenting up to 10.27 % of PB (Table 1) which is higher than the level of CP (9 %) suggested by Figueiras et al. (2010) that would optimize the forage use by grazing cattle.

The supplement intake by a group of animals in each treatment within each experimental period occurred as expected. The average intake of mineral mixture by the calves through the whole experimental period was 30 g/animal/day.

The genetic type of the cows did not affect ($P>0.05$) the final body weight (FBW) and the average daily gain (ADG) of the calves (Table 2).

No differences ($P>0.05$) was observed among supplementation strategies. However, animals that were supplemented equitatively through the whole experiment period showed a greater performance ($P<0.05$) compared to animals from the control group (Table 2).

Similar values of ADG ($P>0.05$) were observed between animals from the control group and those that received increasing levels of supplement. Similarly, calves from the control group presented similar values of ADG than those supplemented from 56th pre-weaning (Table 2).

The efficiencies of supplement used were 0.23, 0.17, and 0.09 kg of BW/kg of supplement by the calves of strategy 1 (calves receiving 0.375 kg/animal/day 112 days prior to weaning), strategy 2 (calves receiving increasing amounts of 0.15, 0.30, 0.45, and 0.60 kg/animal/day through the four experiment periods, in this order) and strategy 3 (calves receiving 0.750 kg/animal/day from 56 days prior to weaning), respectively.

The strategy of supplementation of the calves did not affect ($P>0.05$) the final BW, AVG, BCS, and milk production of the cows (Table 3). Similarly, intake and digestibility of the cows were not affected ($P>0.05$) by strategy of supplementation of the calves (Table 4).

No differences were found ($P>0.05$) for ADG and BCS between Nellore and crossbred cows (Table 3). However, crossbred cows presented greater milk production ($P<0.05$) compared to Nellore cows (Table 3).

Differences were not found ($P>0.05$) between Nellore and crossbred cows for intake of DM, OM, neutral detergent fiber corrected for ashes and protein (NDFap), CP, EE and concentrate non-fiber carbohydrates

Table 2 Least square means and coefficient of variation for final body weight (FBW) and average daily gain (ADG) of suckling female calves according to the strategies of supplementation and genetic type

Item	Supplementation strategies[a]					Genetic type		
	Control	Strategy 1	Strategy 2	Strategy 3	CV (%)	NE×HO	NE	CV (%)
FBW, k[b]	182.9b	192.9a	190.7ab	185.9ab	6.2	189.6	186.7	6.1
ADG, kg/day	0.582b	0.672a	0.651ab	0.609ab	16.5	0.641	0.616	16.2

Means within a row lacking a common letter differ significantly ($P<0.05$)

NE × HO Nellore × Holstein crossbred, *NE* Nellore

[a] strategy 1: supplement provided from 112 days prior to weaning, (0.375 kg/day); strategy 2: supplement provided from 112 days prior to weaning, in increasing amounts of 0.15, 0.30, 0.45, and 0.60 kg/day through the four experimental periods, respectively; strategy 3: supplement provided from 56 days prior to weaning, (0.750 kg/day)

[b] Means adjusted using initial body weight as a covariant

Table 3 Least square means and coefficient of variation for final body weight (FBW), body conditional score (BCS) and milk production (MP) of beef cows according to their genetic type and strategy of supplementation of their calves

Item	Supplementation strategies					Genetic type		
	Control	Strategy 1	Strategy 2	Strategy 3	CV (%)	NE × HO	NE	CV (%)
FBW, kg[a]	435.5	429.0	429.9	424.0	2.7	430.4	429.0	4.0
BCS	3.81	3.83	3.59	3.62	10.1	3.82	3.61	11.3
MP	5.40	6.01	5.74	6.04	16.3	6.21a	5.37b	14.6

Means within a row lacking a common superscript letter differ significantly ($P<0.05$)

NE × HO Nellore × Holstein crossbred, *NE* Nellore

[a] Means adjusted using initial body weight as a covariant

(CCNF), expressed as kg/day, and NDFi expressed as g/kg of BW (Table 4). Conversely, when the intake was expressed as g/kg of BW, crossbred cows present greater DMI ($P<0.05$) compared to Nellore cows (Table 4). Consequently, greater intake of OM, NDFap, and total digestible nutrients was observed for crossbred cows due to the greater DMI compared to Nellore cows (Table 4).

Regarding the nutrient digestibility, no differences were found ($P>0.05$) between Nellore and crossbred cows for digestibility of DM, OM, NDFap, CP, EE, NFC, and NDT (Table 5).

Table 4 Least square means and coefficient of variation for intake of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber corrected for ash and protein (NDFap), indigestible neutral detergent fiber (iNDF), non-fiber carbohydrate (NFC), and total digestible nutrients (TDN) of beef cows according to genetic types

Item	Genetic type		CV (%)
	NE×HO	Nellore	
	kg/day		
DM	9.030	8.980	6.9
OM	8.310	8.260	6.8
CP	0.928	0.926	8.6
EE	0.303	0.302	11.4
NDFap	5.960	5.910	7.2
iNDF	0.871	0.934	14.6
NFC	1.114	1.090	10.5
TDN	4.83	4.82	10.0
	g/kg BW		
DM	22.50a	20.7b	7.7
OM	20.70a	19.04b	7.9
NDFap	14.80a	13.65b	9.0
iNDF	21.57	21.34	7.1
TDN	12.03a	11.12b	10.3

Means within a row lacking a common letter differ significantly ($P<0.05$)

NE × HO Nellore × Holstein crossbred

Discussion

Calves performance and supplement intake

In attempt to understand the beef cattle grazing system, it is necessary to meet all the components of the system (animal, forage, and environment) and their interactions. Therefore, seeking for a better explanation of those interactions led to the development of the concept of PDDM (Paulino et al. 2004).

The PDDM expressed as a function of BW represents quantitatively and qualitatively the amount of forage available for the animal, independent of the stocking rate. Paulino et al. (2004), aiming to associate the animal production per area, suggested the use of 4 and 5 % of BW as PDDM (within 40 and 50 g of PDDM/kg of BW) considering an efficiency of use up to 70 %. Therefore, in the present study, considering the use of 50 g of PDDM/kg of BW daily and the length of the evaluation period for the amount of PDDM (28 days), the momentary availability of 1.4 kg of PDDM/kg of BW (50 g/kg×28 days) would provide adequate offer of PDDM for the cattle until next evaluation, allowing the optimization of animal intake. As shown in Fig. 1b, the amount of PDDM offered to the animals decreased through to experimental periods compared to the availability of PDDM (Fig. 1a) which can be explained by the increase in the body weight of the animals. However, it is noteworthy that the values of PDDM offered stayed above 1.4 kg of PDDM/Kg of BW during the whole experimental period.

A greater efficiency of supplement use was observed by the calves supplemented 112 days prior the weaning (strategy 1) probably due to use of the supplement by the animal as a nutritional complement of the forage. Thus, this strategy may have improved the nutrient balance and favored the forage use concomitantly with a reduction of competition for nutrients among ruminal microorganisms.

According to Sampaio et al. (2010a), the multiple supplementation of suckling calves improves their feed intake and nutrient digestibility. Consequently, it also increases the

Table 5 Least square means and coefficient of variation for digestibility of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber corrected for ash and protein (NDFap), non-fiber carbohydrate (NFC), and total digestible nutrients (TDN) of beef cows according to genetic type

Item	Genetic type		CV (%)
	NE × HO	Nellore	
Total apparent digestibility (%)			
DM	49.21	48.40	5.3
OM	53.8	53.17	4.8
CP	42.36	41.04	15.2
EE	39.00	37.50	35.7
NDFap	60.25	61.66	4.5
NFC	35.48	31.22	31.8
TDN	54.63	54.80	4.1

Means within a row lacking a common letter differ significantly ($P<0.05$)

NE × HO Nellore × Holstein crossbred

amount of nutrients and metabolizable energy that allows an increment of muscle and fat tissue deposition by the animal.

Tarr et al. (1994), in a study evaluating times of creep feeding (0, 28, 56, or 84 days pre-weaning) with ad libitum consumption, observed a greater supplement intake and ADG in calves supplemented for 84 days pre-weaning. On the other hand, the authors reported that a better efficiency of supplement use was obtained with 56 days of supplementation, showing that the greater efficiency in general is not reached by the greater intake.

Lusby (1995), in a study evaluating the effects of three supplementation strategies (limited supplementation; ad libitum supplementation; and no supplementation), observed that calves that received supplement ad libitum presented heavier BW at weaning. However, calves from the limited supplementation group presented a better feed conversion (3.3 kg of DM/kg BW) than those from the ad libitum group (7.8 kg of DM/kg of BW). Thus, it can be inferred that in the ad libitum group, there was substitution of nutrients instead of nutrients supplementation.

In the strategy that calves received increasing amounts of supplement through the experimental period (strategy 2), the low intake of supplement at the first experiment periods may have promoted a low nutritional effect and consequently resulted in a low growth rate of ruminal microorganisms, thus, reducing the utilization of the supplement by the animals and consequently decreasing their performance.

The supplementation 56 days prior the weaning (strategy 3) did not affect ($P>0.05$) animal performance, probably due to the occurrence of substitutive effect. Although more intensely observed in energetic supplementation (Souza et al. 2010), the substitutive effect may occur when high levels of protein supplement is offered in a short period of time (Sampaio et al. 2010b). Thus, the substitution of forage nutrients by supplement nutrients might explain the lack of increases in performance of the calves.

Pacola et al. (1989) in a study evaluating the use or not of creep feeding with 0.328 kg of daily intake of supplement composed by 80 % of corn and 20 % of cotton seed meal, observed greater BW gain for calves that received 5.6 and 13 kg/animal at 4 and 7 months of age, respectively. Similarly, in the present study, the calves that received 0.375 kg/day of supplement (30 % of CP) from 4 to 8 months of age presented a greater BW gain ($P<0.05$) compared to control animals (Table 2). Greater performance of supplemented calves is supported by higher DM intake than non-supplemented calves (Sampaio et al. 2010a).

As recently reported by Oliveira et al. (2010), in grazing cattle under tropical conditions, the protein supplementation increases the digestibilities of DM, NDF, and the passage rate, increasing the amount of energy as a volatile fatty acids and microbial protein production (Oliveira et al. 2009). Therefore, protein supplementation improves feed utilization and increases the amount of energy and nutrients available for the cattle, resulting in a greater animal's performance.

Strategies such as creep feeding, which allows the calf access concentrate at early stage, have been successfully used to progressively reduce its nutritional and social dependence on the cow (Enríquez et al. 2011). Thus, supplementation of

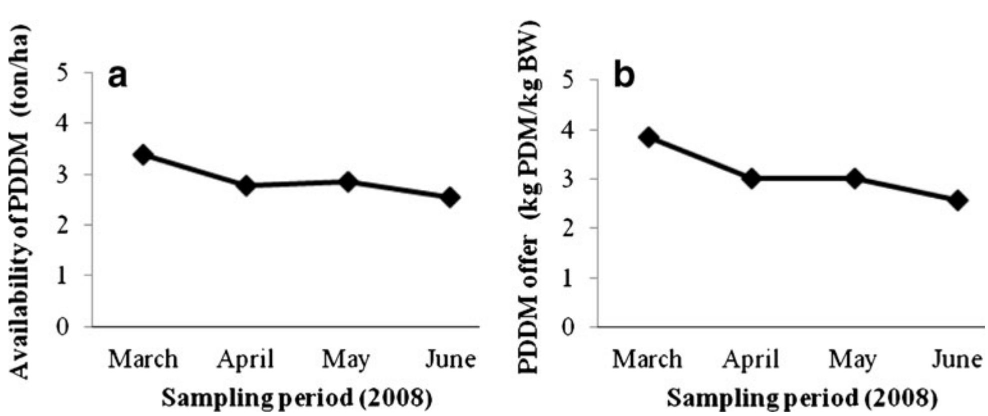

Fig. 1 Availability of potentially digestible dry matter (*PDDM*) total (**a**) and offer (**b**)

calves may increase weight gain during sucking period, reduces the weaning stress, and consequently improves the performance post-weaned. One of the main reasons for performance improvement in this case might be a better ruminal condition at early stage of development which allows a better grazing efficiency.

Cow's milk production, performance, feed intake, and digestibility

According to Kress et al. (1990), the suckling frequency determines milk production and the physical conditions of the dams, where a high frequency of suckling may increase milk production and concomitantly compromise the physical conditions of the cows. Nonetheless, in the present study, milk production was not affected ($P>0.05$) by the supplementation of the calves, being in accordance with the results reported by Gelvin et al. (2004). However, according to Fordyce et al. (1996), the supplementation of calves may decrease milk production of the cows due to a reduction in suckling stimulation. In addition, solid intake by calf is negatively correlated to milk yield (Henriques et al. 2011). Thus, it seems that the supplement used in the present study was not enough to change the suckling behavior of the calves and consequently did not affect ($P>0.05$) cow's milk production, BCS, and BW (Table 3).

A greater milk production of crossbreed cows may be explained by their greater genetic potential for milk production, since they have Holstein breed in their genetic composition. Nellore cows produced an average of 5.37 kg/day of milk, being greater than the values reported by Oliveira et al. (2007) who observed a milk production of 5 kg/day from Nellore cows.

Regarding the cow's feed intake, the results obtained in the present study are in accordance with those reported by Azevêdo et al. (2010), Alves et al. (2004), and Euclides Filho et al. (2002) who observed lower values of feed intake for Nellore cattle compared to European breed animals. Even though differences were found in intake of Nellore and crossbred animals, a greater difference would be observed in a comparison of Nellore and European pure breed animals (Coleman et al. 2012), due to the genetic proximity of crossbred and Nellore animals.

A greater DMI by the crossbred cows (Table 4) can be explained by their higher energy and nutrient requirement, since those animals presented greater milk production (Table 3). According to Vargas Junior et al. (2010), crossbred grazing cows (*B. taurus* × *B. indicus)* usually spend more time grazing than Nellore cows in order to meet their nutritional requirements. According to NRC (1996), beef cows with mature body weight of 450 kg and 5 month of lactation, producing 5 kg of milk per day, would present values of 10.6 kg/day for DMI, which corresponds approximately 23.5 g/kg of BW. In the present study, the DMI of Nellore cows (20.7 g/kg of BW) was lower than those suggested by NRC (1996). The DMI estimated by NRC (1996) is based on European breed animals, which presents a greater DMI than Zebu animals due to their larger gastrointestinal tract (Menezes et al. 2007) being a possible explanation for the values of DMI observed for crossbred animals in this study, since they have Holstein breed in their genetic composition.

According to Valadares Filho et al. (1987), Zebu animals presents a greater digestibility than Holsteins and crossbred cattle (Zebu × Holsteins) due to their great efficiency for N utilization. However, in the present study, no differences were observed ($P>0.05$) for dry matter digestibility (DMD) between genetic groups (Table 5). This result was probably due to the phenotypic similarity of those animals, since the Nellore breed contribute with more than 50 % on the genetic composition of crossbred cows. Moreover, the better N utilization by Zebu animals that is responsible for the improvement of the degradability of low quality forage probably had little effects on DMD since the forage used in this study presented moderated level of CP (8.79 %), being close to the minimum level (9 %) necessary for the optimization of the use of forage by grazing cattle under tropical conditions (Figueiras et al. 2010).

Conclusions

A supplementation strategy that provides equitatively amounts of supplement through the pre-weaning period increases the BW gain compared to animals that receive only mineral mixture. The supplementation strategy of suckling calves does not affect the BW gain, body condition score, and milk production of dams. Crossbred cows present greater milk production and DMI than Nellore cows. However, there is no difference of nutrient digestibility between Nellore and Nellore × Holstein crossbred cows.

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