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Does supplementation during previous phase influence performance during the growing and finishing phase in Nellore cattle?

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ABSTRACT

In Brazil, the beef cattle are widely raised in pasture post weaning, but the supplementation has been studied only in individual phases of the animal's growth curve. Therefore, the objective of this study was evaluated the nutritional interrelationship between the growing and finishing phases in the performance of Nellore bulls. Eighty-four weaned calves (body weight [BW] = 205 ± 4.7 kg; 8 months) raised on pasture during the growing phase (dry season, summer and autumn) and finished in feedlot were used. The experiment was conducted as a randomized block design with a 2 × 2 × 3 factorial arrangement of treatments. Factors included 1) two supplements levels in the dry season (protein [1 g/kg BW/day - PR1] or protein-energy [3 g/kg BW/day - PE] supplement); 2) two supplement levels in summer (mineral supplement [*ad libitum* - MS] or protein supplement [1 g/kg BW/day - PR2]); and three supplement levels in autumn (MS, PR2 or PE). The animals were finished with a common diet. The dry season supplementation affected the average daily gain (ADG) in the summer ($P < 0.05$). In summer, animals fed MS had a greater ADG when fed PR1 in the previous (dry) season than those receiving PE (0.696 vs. 0.581 kg, $P < 0.01$); while, no difference in ADG was observed when the animals received PR2 (0.815 kg, $P = 0.99$). In autumn, animals fed PR2 in the previous (summer) season exhibited 11.3% lower ADG than those supplemented with MS (0.503 vs. 0.567 kg, $P < 0.01$), regardless of the autumn supplementation. Dry season supplementation did not affect the ADG during finishing phase (0.909 kg, $P = 0.14$). The animals fed PR2 in the summer and PE in the autumn had tendency of lower ADG during the feedlot ($P = 0.06$) compared with animals fed MS, however, they were finished 20 days earlier ($P = 0.06$). In conclusion, to provide PE in the dry season, followed by MS in the summer is not recommended, because this strategy reduces the ADG. In addition, dry season supplementation does not affect the ADG during finishing phase, while supply supplements of greater nutritional value in autumn reduces feedlot period.

1. Introduction

Cattle production in the tropics mainly relies on pasture systems (Ferraz and Felício, 2010). Thus, there is rarely a balance on pasture systems between the supply and requirement of nutrients because of seasonal fluctuations in the quantity and quality of forage (Detmann et al., 2014). To overcome this condition, supplementation is used to improve the efficiency of pasture utilization and to optimize animal performance (Casagrande et al., 2011). However, the supplementation has been evaluated in individual periods such as the dry season, summer, or autumn in tropical conditions (Barbero et al., 2017; Detmann et al., 2014; Moretti et al., 2013).

The nutritional strategy promotes metabolic and physiological alterations, as well as changes in the composition of body weight gain, in the subsequent phase of the animal's growth curve (Keogh et al., 2015; Pesonen et al., 2014; Sainz et al., 1995;). Nevertheless, most studies have evaluated the effect of supplementation during the growing phase on the finishing performance of cattle, considering the growing phase to be nutritionally uniform under non-tropical conditions (Drouillard and Kuhl, 1999; McCurdy et al., 2010; Neel et al., 2007). In addition, *Bos indicus* cattle are mainly used in tropical systems (Ferraz and Felício, 2010), and their growth pattern differs from *Bos taurus* (Oliveira et al., 2011).

Within this context, the objective of this study was to understand the interrelationship of supplementation strategies provided to Nellore bulls during the growing phase, as well as the effects of the supplement strategies offered during the growing phase on the finishing performance of the animals. The hypothesis for this study was that the

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nutritional strategy provided to the bulls in a previous phase will alter the subsequent performance, as well as carcass traits at the end of the finishing period. Furthermore, the adequate growth of the animal depends of the nutritional strategy provided in a certain phase and this one should be the same or greater in subsequent phases.

2. Materials and methods

The study was conducted in Colina, São Paulo, Brazil (20°43′5″S and 48°32′38″W). All procedures involving animals were conducted in accordance with the ethical guidelines adopted by the Brazilian Guidelines for the Care and Use of Animals for Scientific and Educational Purposes (CONCEA, 2013).

2.1. Experimental period, grazing area and feedlot

The experimental period comprised the growing and finishing phases of the Nellore bulls. The growing phase was divided into the dry season (from July 16 to December 11, 148 days), summer (from December 12 to March 12, 90 days), and autumn (from March 13 to June 26, 105 days). The summer and autumn periods corresponding to the rainy season. The growing phase was followed by the finishing phase (from June 27 up to reaching 500 kg of body weight [BW]).

During the dry season, the grazing area consisted of Marandu grass (*Brachiaria brizantha* cv. Marandu) divided into 12 paddocks (2.16–2.40 ha each). Each paddock had drinkers and feeding troughs for the supplements. In summer and autumn, 6 rotational stocking management systems of Tanzania grass (*Panicum maximum* cv. Tanzania) were used. Each rotational stocking system had a central area containing the drinkers and feeding troughs for the supplements and was divided into five paddocks of 1.3 ha each. The drinkers had a capacity of 1500 L and the linear feeding trough space per animal was 30 cm. During finishing phase, the animals were housed in collective pens (240 m^2) in a feedlot equipped with drinker and feed bunks.

2.2. Experimental animals, treatments, experimental design and feedlot diet

All experimental animals belonged to the herd of the farm and they were managed in the same way until weaning. Eighty-four bulls, newly weaned Nellore calves (BW = 205 ± 4.7 kg; 8 months) were used. The animals were weighed, dewormed with 1% Ivermectin (Ivomec, Merial, Paulínea, SP, Brazil), and identified individually with ear tags. In addition to the experimental animals, other animals were used when necessary to adjust the grazing pressure and to maintain the same forage supply in all paddocks.

Proposed treatments were designed to ideally provide different rates of gain to the animals during the growing phase. The selection and definition of the supplements were based on their representative use under tropical conditions (Detmann et al., 2014). The variations in the composition and levels of the supplements, as well as in the number of supplements in each seasons of the year, were due to the intrinsic characteristics of each season under tropical conditions (Table 1).

In the dry season, the experiment was conducted as a randomized block design with two supplements levels: protein (1 g/kg BW/day - PR1) or protein-energy (3 g/kg BW/day - PE) supplement. The experimental unit was the animal (42 animals per treatment). In the summer, the experiment was conducted as a randomized block design with a 2 × 2 factorial arrangement of treatments. Factors included 1) two supplements levels in the dry season (PR1 or PE supplement); 2) two supplement levels in summer (mineral supplement [ad libitum - MS] or protein supplement [1 g/kg BW/day - PR2]). The experimental unit was the animal (21 animals per treatment). In the autumn and feedlot, the experiment was conducted as a randomized block design with a 2 × 2 × 3 factorial arrangement of treatments. Factors included 1) two supplements levels in the dry season (PR1 or PE); 2) two supplement levels in summer (MS or PR2); and three supplement levels in autumn (MS, PR2 or PE). The experimental unit was the animal (7 animals per treatment). The randomization of animals in each season allowed us to comply with the nutritional strategy of each animal (Table 2). During the growing phase, the supplement was provided daily at 08:00 h.

In the feedlot, a common diet was formulated to achieve an estimated average daily gain (ADG) of 1.25 kg/day (NRC, 2000). The finishing total mixed ration contained sugarcane silage (400 g/kg), cottonseed meal (66.5 g/kg), soybean hull (365 g/kg), ground corn (109 g/kg), urea (17.7 g/kg), and mineral premix (41.8 g/kg). The total mixed ration was provided twice a day (08:00 h and 15:00 h) at equal amounts using a forage wagon (Rotomix Express, Casale, São Carlos, SP, Brazil) equipped with a scale. The orts of the previous day were collected and weighed to adjust the total mixed ration supply before

Table 1
Composition of the supplements offered in the dry season (from July 16 to December 11, 148 days), summer (from December 12 to March 12, 90 days), and autumn (from March 13 to June 26, 105 days).

Item	Supplement			
	MS	PR1	PR2	PE
	Ingredient, g/kg dry matter			
Cottonseed meal	–	419	290	317
Pelleted citrus pulp	–	80	288	562
Urea	–	124	17	34
Sodium chloride	–	115	39	37
Mineral premix	–	262	366	50
	Composition			
Crude protein, g/kg	–	500	300	250
NPN equivalent protein, g/kg	–	530	130	90
Estimated total digestible nutrients, g/kg	–	400	400	600
Calcium, g	155	50	77	23
Phosphorus, g	80	33	20	6
Sodium, g	130	15	30	13

MS = mineral supplement *ad libitum*; PR1 = dry season protein supplement offered at 1 g/kg body weight (BW) per day; PR2 = protein supplement offered at 1 g/kg BW per day (summer and autumn); PE = protein-energy supplement offered at 3 g/kg BW per day (dry season and autumn); NPN = non-protein nitrogen.
Composition MS, in g/kg: magnesium 10; sulfur 40; in mg/kg: copper 1350; manganese 1040; zinc 5000; iodine 100; cobalt 80; selenium 26; fluoride 800.
Composition premix PR1, in g/kg: magnesium 2; sulfur 66; in mg/kg: copper 2; manganese 15; zinc 40; iodine 260; cobalt 200; selenium 960; fluoride 19; monensin 15.
Composition premix PR2, in g/kg: magnesium 2; sulfur 20; in mg/kg: copper 345; manganese 265; zinc 1280; iodine 25; cobalt 20; selenium 6; fluoride 200; monensin 200.
Composition premix PE, in g/kg: magnesium 1; sulfur 3; in mg/kg: copper 40; manganese 30; zinc 148; iodine 3; cobalt 2; selenium 1; fluoride 60; monensin 80.

Table 2
Experimental design and supplementation strategies (dry season = July 16 to December 11, 148 days; summer = December 12 to March 12, 90 days; autumn = March 13 to June 26, 105 days; finishing = June 27 up to reaching 500 kg).

Dry season *n* = 84	Summer *n* = 84	Autumn *n* = 84	Finishing *n* = 84	Slaughter *n* = 84
PR1 *n* = 42	MS *n* = 21	MS *n* = 7	Feedlot *n* = 7	*n* = 7
		PR2 *n* = 7	Feedlot *n* = 7	*n* = 7
		PE *n* = 7	Feedlot *n* = 7	*n* = 7
	PR2 *n* = 21	MS *n* = 7	Feedlot *n* = 7	*n* = 7
		PR2 *n* = 7	Feedlot *n* = 7	*n* = 7
		PE *n* = 7	Feedlot *n* = 7	*n* = 7
PE *n* = 42	MS *n* = 21	MS *n* = 7	Feedlot *n* = 7	*n* = 7
		PR2 *n* = 7	Feedlot *n* = 7	*n* = 7
		PE *n* = 7	Feedlot *n* = 7	*n* = 7
	PR2 *n* = 21	MS *n* = 7	Feedlot *n* = 7	*n* = 7
		PR2 *n* = 7	Feedlot *n* = 7	*n* = 7
		PE *n* = 7	Feedlot *n* = 7	*n* = 7

MS = mineral supplement ad libitum; PR1 = dry season protein supplement offered at 1 g/kg body weight (BW) per day; PR2 = protein supplement offered at 1 g/kg BW per day (summer and autumn); PE = protein-energy supplement offered at 3 g/kg BW per day (dry season and autumn).