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Effects of protein supplementation on metabolism and performance of grazing Nellore cows with different parities

Efeitos da suplementação proteica no metabolismo e desempenho de vacas Nelore em pastejo sob diferentes ordens de parto

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Highlights

Multiparous Nellore cows have greater body reserve mobilization at calving.
Unsupplemented primiparous cows have poorer blood protein status.
Postpartum supplementation improves the performance of grazing Nellore cows.

Abstract

The objective was to evaluate the interaction between parity and postpartum supplementation on performance and blood metabolism of grazing Nellore cows. Forty Nellore cows were used. The experimental design was completely randomized, in a 2 × 2 factorial arrangement, represented by two parity classes: primiparous (P1) and multiparous (P2), and two postpartum supplementation strategies, as follows: unsupplemented (N), and supplemented (S). Overall, supplementation tended to increase cow weight gain (P < 0.09), regardless of parity, but did not affect body condition score (BCS) (P > 0.20).

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In addition, supplementation increased calf weight at 42 days of age ($P < 0.01$), as well as milk protein and lactose concentrations ($P < 0.03$) On the other hand, multiparous cows had higher milk production ($P < 0.01$), and their calves had higher average dairy gain (ADG) ($P < 0.04$). There was interaction between postpartum day and parity ($P < 0.03$), in which multiparous cows had higher blood non-esterified fatty acid (NEFA) concentrations at calving. There was an interaction between calving order and supplementation on blood albumin ($P < 0.05$), with lower values for unsupplemented primiparous cows. In addition, supplementation increased insulin like growth factor (IGF-1) in the blood ($P < 0.01$). Postpartum supplementation improves the productive performance of cows. In addition, multiparous cows exhibit greater body reserve mobilization at calving, whereas unsupplemented primiparous cows have poorer blood protein status.
Key words: Calves. IGF-1. NEFA. Tropical pastures. Zebu.

Resumo

O objetivo foi avaliar a interação entre a ordem de paridade e suplementação pós-parto sobre o desempenho e metabolismo sanguíneo de vacas de corte Nelore em pastejo. Foram utilizadas 40 vacas Nelore, em delineamento inteiramente casualizado, em arranjo fatorial 2 × 2, representando duas ordens de paridade: primíparas (P1) e multíparas (P2), e duas estratégias de suplementação pós-parto: não suplementadas (N) e suplementadas (S). De modo geral, a suplementação tendeu a aumentar o ganho de peso das vacas ($P < 0,09$), independentemente da ordem de paridade, mas não alterou o escore de condição corporal (ECC) ($P > 0,20$). Além disso, a suplementação aumentou o peso dos bezerros aos 42 dias de idade ($P < 0,01$), bem como as concentrações de proteína e lactose no leite ($P < 0,03$). Por outro lado, as vacas multíparas apresentaram maior produção de leite ($P < 0,01$), e seus bezerros obtiveram maior ganho médio diário (GMD) ($P < 0,04$). Houve interação entre o dia pós-parto e a ordem de paridade ($P < 0,03$), na qual as vacas multíparas apresentaram maiores níveis sanguíneos de ácidos graxos não esterificados (AGNE) no momento do parto. Observou-se interação entre a ordem de paridade e a suplementação em relação à albumina sanguínea ($P < 0,05$), com valores inferiores para as vacas primíparas não suplementadas. Adicionalmente, a suplementação aumentou os níveis sanguíneos do fator de crescimento semelhante à insulina (IGF-1) nos animais ($P < 0,01$). A suplementação pós-parto melhora o desempenho produtivo das vacas. Além disso, as vacas multíparas apresentam maior mobilização corporal no momento do parto, enquanto as vacas primíparas não suplementadas demonstram o pior estado proteico sanguíneo.
Palavras-chave: Bezerros. IGF-1. NEFA. Pastos tropicais. Zebu.

Introduction

The postpartum period of primiparous beef females is challenging because of their high nutritional requirements, which can compromise performance during the breeding season and reduce the weaning weight of their calves. Cows experiencing their first calving are therefore in a different metabolic state from multiparous cows (Coffey et al., 2006), as they require nutrients for continued growth and for supporting calf development. This situation is further exacerbated in beef cows raised on pasture, as forage rarely provides a balanced diet for these animals (Reis et al., 2020). Adequate nutrition is crucial for primiparous females to avoid the premature culling of cows with high genetic potential due solely to inadequate nutritional management

Indeed, Ferreira et al. (2021) demonstrated that blood indicators of protein status during lactation are directly influenced by parity. Primiparous females exhibit more unbalanced metabolic and hormonal profiles, accompanied by a greater body condition loss. Similarly, Cattaneo et al. (2023) reported that primiparous dairy cows display a distinct metabolic and endocrine status compared with multiparous cows. Several studies have evaluated the effects of postpartum nutrition on the metabolism of dairy cows with different parities (Nasrollahi et al., 2017; Neave et al., 2018). However, regarding Zebu cows under grazing conditions, to the best of our knowledge, no studies have evaluated the productive and metabolic responses of cows with different parities to supplementation. Although some studies have compared the performance and metabolism of Nellore cows of different parities in the postpartum period, all animals received protein supplementation. Therefore, it remains unclear whether cows of different parities respond differently to supplementation in terms of productive performance and metabolic adaptations.

Understanding the metabolic patterns of multiparous and primiparous cows under different nutritional plans is essential to minimize the negative effects of homeorhetic processes (e.g., lactation) on animal performance. In addition, adequate nutritional management is particularly important for primiparous cows to avoid the premature culling of females with high genetic potential due to nutritional limitations. We hypothesized that postpartum supplementation would result in greater productive and metabolic benefits in primiparous cows than in multiparous cows. Therefore, this study aimed to evaluate the effects of postpartum supplementation on productive performance and metabolic status of Nellore cows of different parity classes managed under grazing conditions.

Material and Methods

The experiment was conducted at the Universidade Federal de Vicosa, Vicosa, MG, Brazil (20° 45' S, 42° 52' W). During the experimental period, the average temperature and rainfall were 21.5º C and 557.6 mm (INMET- Viçosa Station A510), respectively. All procedures involving animals were approved by the Ethics Committee on the Use of Production Animals of the university (case 52/2021).

Forty pregnant Nellore cows were used, including16 nulliparous and 24 multiparous, averaging 429 ± 40.9 kg and 523 ± 24.0 kg of body weight, respectively, with body condition score (BCS) of 6.4 ± 0.3 and 6.3 ± 0.6, and ages of 2.5 ± 0.5 y and 6.2 ± 2.3 y, respectively. Because evaluations were conducted during the postpartum period, nulliparous cows were thereafter referred to as primiparous cows. The experimental design was completely randomized, in a 2 ×2 factorial arrangement, with two parity classes: primiparous (**P1**) and multiparous (**P2**), and two postpartum supplementation strategies: unsupplemented (**U**; cows receiving only mineral mixture *ad libitum*) and supplemented (**S**; cows receiving 1.0 kg day^{-1} of protein supplement and mineral mixture *ad libitum* (percentage composition of the mineral mixture [g kg^{-1}]: dicalcium phosphate 500, sodium chloride 471.9, zinc sulfate 15.0, copper sulfate 7.00, manganese sulfate 5.00, cobalt sulfate 0.50, potassium iodate 0.50 and sodium selenite 0.10)). The protein supplement was formulated to contain 25% crude protein on a dry matter basis, with the following composition (g kg^{-1}): wheat bran, 475; corn meal, 350; soybean meal, 150; and urea:ammonium sulfate, 25. The supplement was provided daily at 11:00. Furthermore, animals received ecto- and endoparasite control as needed. Maternal treatments started at parturition and continued until day 42 postpartum. For the evaluations, the cows were allocated so that each paddock contained only animals of one parity class, with four paddocks assigned to each parity class.

The cows and their respective offspring were weighed, without fasting, on the 42nd day postpartum, to assess the average daily gain (**ADG**). Simultaneously, the cow body condition score (**BCS**) was evaluated independently by three experienced assessors, and the average score was calculated for each animal.

Pasture samples were collected every 28 days to quantify total dry matter (**TDM**) and potentially digestible dry matter (**pdDM**). The forage availability was assessed by using a metal quadrat (0.5 × 0.5 m) at four randomly chosen points within each paddock. Simultaneously, forage samples were collected from each paddock by hand-plucked sampling to assess the chemical composition of consumed forage. All samples were weighed, dried at 55°C for 72 h, and ground using a Wiley® mill (model 3, Arthur H. Thomas, USA).

To estimate milk yield, machine milking was performed at 7 and 42 d postpartum. Cows were separated from their calves at 18h00, and on the following day at 06h00, 2 mL of oxytocin (10 IU mL^{-1},Ocitovet®, Brazil) were injected into the mammary vein, and milking was conducted immediately afterward. The exact interval between calf separation and milking was recorded, and milk production was proportionally adjusted to a 24-h production basis (Lopes et al., 2022). Milk yield was corrected to 4%-fat (**CMY4%**) according to the NRC (2001): CMY4% = (0.4 × MY) + (15 × F) × (100 × MY)$^{-1}$, where CMY = corrected milk yield (kg.day^{-1}), MY = milk yield (kg), and F = fat (%). Moreover, a 30 mL milk sample from morning and afternoon milkings was collected from each cow to evaluate milk composition.

Blood samples were collected at 07h00 on days 0, 7, 14, 28, and 42 postpartum by jugular venipuncture using vacuum tubes containing clot activator and gel separator (BD Vacutainer® SST® II Advance®, Brazil) for serum collection. Serum was used to quantify serum urea nitrogen (SUN), total protein, albumin, globulin, creatinine, triglycerides, total cholesterol, high-density lipoprotein (HDL), non-esterified fatty acids (NEFA), β-hydroxybutyrate (βHB), insulin, insulin-like growth factor 1 (IGF-1), total triiodothyronine (T3), and total thyroxine (T4). Blood samples for plasma glucose determination were collected into tubes containing EDTA and sodium fluoride (BD Vacutainer® Fluoride/EDTA, Brazil). After collection, blood samples were centrifuged at 3,600 × g for 15 min, and serum and plasma were separated into microtubes and stored at −20°C until analysis.

Samples of forage and supplement were oven-dried at 55 °C and subsequently processed to pass through 1 mm and 2 mm sieves. Samples of forage (hand-plucked) were analyzed for dry matter (DM, dried for 16 h at 105 °C, INCT method-CA G-003/1), ash (complete combustion at 550 °C, method M-001/2), neutral detergent fiber (NDF, method F-013/1), corrected for ash (M-002/2) and protein (N-004/2), and N (Kjeldahl method, INCT-CA method N-001/2) according to the standard analytical procedures of the Brazilian National Institute of Science and Technology in Animal Science INCT-CA (Detmann et al., 2021), using the samples through a 1 mm sieve. The content of indigestible neutral detergent fiber (iNDF) was estimated through a 288 h in situ incubation procedure through a samples processed at 2 mm sieve (Detmann et al., 2021). In the forage samples for availability (i.e., TDM and pdDM), the contents of DM, NDF and iNDF were quantified, according to the methods described above.

Potentially digestible DM (pdDM) was estimated according to Paulino et al. (2004), as follows: pdDM = 0.98 x (100 – NDF) + (NDF – iNDF). Milk samples were analyzed for protein, fat, lactose, and total solids contents using infrared spectroscopy (Foss MilkoScan FT120, São Paulo, Brazil). Bioclin® kits (Belo Horizonte, Brazil) were used to measure plasma glucose concentrations (K82) and serum concentrations of urea (K056), total protein (K031), albumin (K040), total cholesterol (K083), triglycerides (K117), and HDL (K071). Serum concentrations of NEFA and beta-hydroxybutyrate (βHB) were measured using Randox® kits (A115 and RB1007, United Kingdom). All the above analyses, except for insulin-like growth factor 1 (IGF-1), were performed on an automated biochemical analyzer (Mindray Co. Ltd., BS-200E, China). Serum IGF-1 concentrations were measured using Siemens® kits (Berlin, Germany) on an automated chemiluminescence analyzer.

Low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) values were estimated according to Friedewald et al. (1972) using the equation: CT = HDL + LDL + VLDL, where CT means total cholesterol (%), HDL means high-density lipoprotein (%), LDL represents low-density lipoprotein (%), and VLDL stands for very low-density lipoprotein (%). The VLDL value was calculated as one-fifth of the measured of triglyceride concentration. Globulin concentration was calculated as the difference between total protein and albumin concentrations. Serum urea nitrogen (SUN) was estimated as 46.67% of the serum urea concentration.

The statistical model used was: $Yijk = \mu + \alpha i + \beta j + (\alpha\beta)ij + eijk$, where, Yijk = observation of the dependent variable corresponding to animal of parity j, subjected to postpartum supplementation strategy i in paddock k, μ = overall constant, αi = fixed effect of supplementation strategy, βj = fixed effect of parity (multiparous and primiparous), (αβ)ij = interaction between fixed effects, eijk = random error. Metabolic variables were analyzed in repeated measures over time, considering the interaction between treatments and evaluation days as a fixed effect. Significances were declared if $P \leq 0.05$, and trends were declared when $0.05 < P \leq 0.10$. The residues were verified for normality by the Shapiro-Wilk test and the homogeneity of variances by the Bartlett test. All procedures were performed in the R software, Agricolae package.

Results and Discussion

Chemical composition of the forage and supplement is presented in Table 1. Our main objective was to determine whether primiparous cows would exhibit a greater productive and metabolic response to supplementation than multiparous cows. However, our hypothesis was not supported by the present findings. No interaction ($P \geq 0.28$) between parity and supplementation was observed for any performance variable (Table 2). Nevertheless, supplemented cows tended ($P < 0.09$) to exhibit greater ADG regardless of parity. In this study, forage crude protein concentration averaged 99.5 g/kg DM. Previous studies conducted under tropical conditions have demonstrated that even high-quality tropical forages may not provide an adequate balance between energy and protein supply for grazing cattle (Detmann et al., 2014; Reis et al., 2020). Under these conditions, protein supplementation may improve nutrient utilization efficiency and increase the supply of metabolizable nutrients to the animal, thereby enhancing productive performance. This interpretation is consistent with previous studies conducted with Nellore cows under tropical grazing conditions (Almeida et al., 2020; Moreno et al., 2023). Similarly, supplementation increased blood IGF-1 concentrations in both multiparous and primiparous cows (Table 2; $P < 0.02$). Hormones such as insulin and IGF-1 are important activators of the mTOR signaling pathway, which serves as a critical regulator of protein synthesis and inhibits protein degradation (Takahara et al., 2020). Indeed, circulating IGF-1 concentrations are positively associated with body nitrogen accretion (Reis et al., 2020).

Table 1
Chemical composition of the forage and supplement (g kg^{-1} dry matter)

Item	Supplement	Forage
Dry matter, as-fed	930	313±0.43
Organic matter	997	919±0.14
Crude protein	231	99.5±0.27
Neutral detergent fiber	175	608±0.35
iNDF	73	308±0.39

iNDF: indigestible neutral detergent fiber.

Table 2
Effects of parity and supplementation on the performance of cows and their offspring

Item	Treatment[1]				SEM	P-value[2]		
	UP1	SP1	UP2	SP2		S	P	P × S
ADG_{Cow}	0.27	0.29	0.33	0.41	0.008	0.08	0.01	0.28
Initial BCS	6.5	6.2	6.5	6.3	0.07	0.09	0.57	0.53
Final BCS	6.3	6.4	6.2	6.4	0.06	0.20	0.53	0.50
Calf weight[3]	30	35	37	37	0.9	-	0.01	-
Calf weight[4]	79	84	84	90	6.3	<0.01	<0.01	0.35
$ADG_{C}alf$	1.17	1.17	1.13	1.26	0.008	0.06	0.03	0.52
CMY4, kg	6.6	5.5	9.1	10.8	0.60	0.40	<0.01	0.20
Fat, %	3.8	3.3	4.8	4.7	0.20	0.30	<0.01	0.38
Protein, %	3.4	3.3	3.4	3.3	0.08	0.02	0.45	0.71
Lactose, %	4.2	4.6	4.5	4.6	0.06	0.02	0.44	0.16
Total solids, %	12.5	12.4	13.8	13.7	0.21	0.64	<0.01	0.83

[1]Unsupplemented primiparous **(UP1)**, supplemented primiparous **(SP1)**, unsupplemented multiparous **(UP2)**, and unsupplemented multiparous (SP2). [2]S: supplementation effect; P: parity effect; P × S:interaction effect between parity and supplementation. SEM: standard error of the mean; CMY4: 4% fat-corrected milk yield. [3]Calf birth weight; [4]Calf weight at 42 days of age; ADG: average daily gain; BCS: body condition score

Parity affected cow ADG (*P* < 0.02), with multiparous cows exhibiting (0.085 kg/d) greater ADG than primiparous cows (Table 2), consistent with the findings of Nishimura et al. (2023) in Nellore cows. However, gain rate (kg day^{-1} per100 kg BW) was similar across parity classes, averaging 0.07 kg/100 kg BW. In contrast, the BCS was not affected by supplementation or parity (*P* > 0.20). Calf birth weight and ADG were also affected by parity (*P* < 0.02), with greater values observed in offspring born to multiparous cows (Table 2). Additionally, multiparous cows had greater corrected milk yield and higher concentrations of fat and total solids in milk than primiparous cows (*P* < 0.02). The greater calf ADG from multiparous cows is associated with higher milk yield and milk solids production by their dams. There is a consensus in the literature that primiparous Nellore cows have lower production than multiparous cows (Lopes et al., 2022). Indeed, secretory tissue volume and mammary tissue growth rates are greater during the second gestation than during the first in dairy cattle, and the mammary gland of multiparous cows is metabolically more active than that of primiparous cows (Knight & Wilde, 1993; Miller et al., 2006). These physiological differences may partially explain the greater milk production observed in multiparous cows in the present study.

On the other hand, supplementation increased calf body weight at the 42 days of age (*P* < 0.02), regardless of parity class (Table 2). Supplementation also increased milk lactose concentration (*P* < 0.03), possibly due to the greater supply of glucose and/or gluconeogenic precursors (*e.g.*, amino acids). Thus, the improved performance of calves born to supplemented cows is associated with increased lactose yield in milk, as demonstrated by Almeida et al. (2020).

Previous studies have suggested that primiparous Nellore cows exhibit different postpartum metabolic patterns compared to multiparous cows (Ferreira et al., 2021). Therefore, our objective was to evaluate whether supplementation would induce similar metabolic changes in primiparous and multiparous cows. Overall, no interaction between parity and supplementation was observed for most metabolic variables ($P \geq 0.24$), except for albumin levels ($P < 0.05$), with the lowest values observed in unsupplemented primiparous cows (Table 3), possibly due to the greater nutritional requirements and lower dietary protein intake by diet in this treatment. Furthermore, there was a day effect ($P < 0.02$) for albumin, with concentrations decreasing throughout lactation. This decline is likely related to the increased demand for amino acids by the mammary gland during early lactation (Cunningham and Klein, 2013).

Supplemented animals had lower concentrations of total cholesterol and LDL ($P < 0.02$) than unsupplemented animals. Although the greater concentrations of total cholesterol and LDL observed in unsupplemented cows may suggest more intense mobilization of body reserves, no differences were detected in NEFA concentrations or BCS between treatments.

Multiparous cows exhibited greater globulin concentrations than primiparous cows ($P < 0.02$; Table 3). Globulins are not reliable indicators of protein metabolism, being more closely associated with inflammatory and immune responses (Ferreira et al., 2021). The lower serum globulin concentrations in primiparous cows may indicate greater globulin transfer to colostrum or simply reflect a lower capacity to produce high-quality colostrum. In fact, it has been documented that colostrum from primiparous *Bos taurus* cows contains lower IgG concentrations than multiparous cows, which is reflected in the antibody concentrations of their calves (Brereton et al., 2024). Furthermore, primiparous cows had lower milk production than multiparous cows, and this trend is also observed for colostrum. Collectively, these findings reinforce the importance of greater management attention to calves born from primiparous cows, particularly regarding adequate passive immunity transfer. Furthermore, blood globulin concentrations increased throughout lactation ($P < 0.02$; Figure 1). In general, globulins are more closely associated with the immunological memory of animals rather than to protein metabolism. Reduced globulin levels before parturition and during early lactation are explained by the transfer of immunoglobulins to colostrum (Larson, 1958).

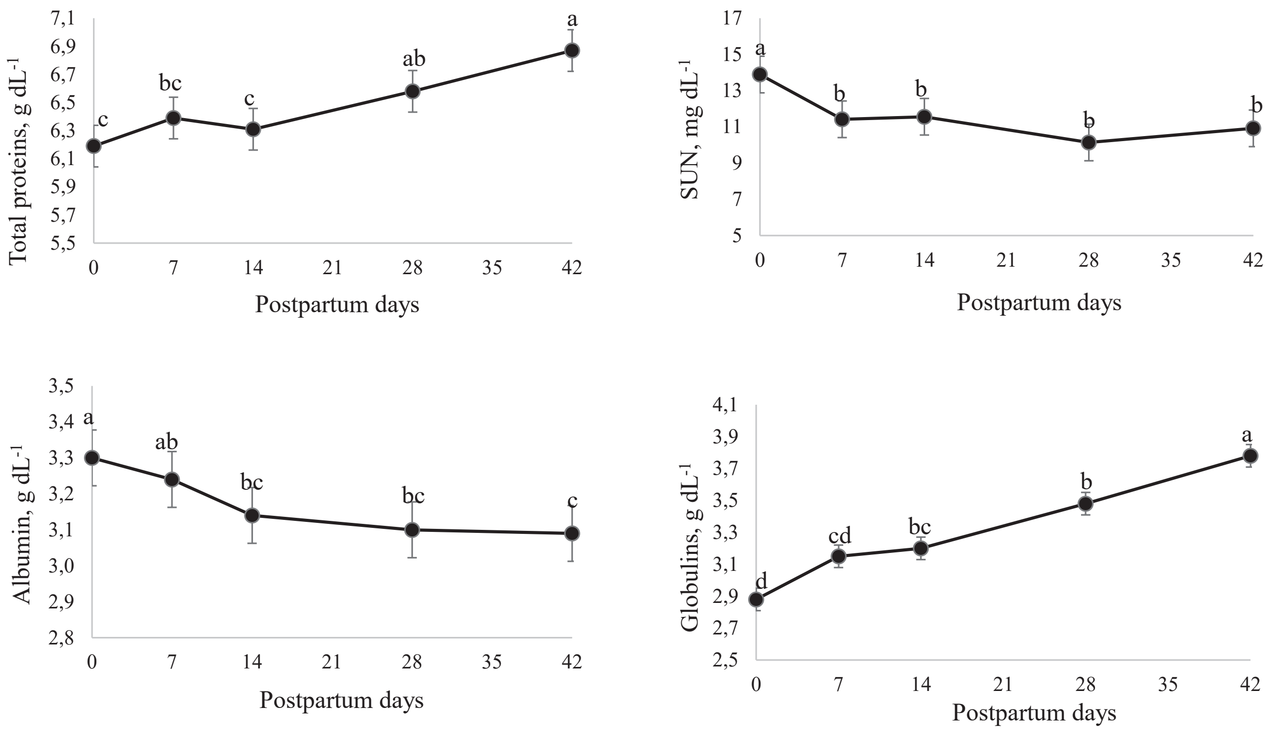

Figure 1. Postpartum blood concentrations of serum urea nitrogen (SUN), total proteins, albumin, and globlulins in grazing beef cows on tropical pasture. Different letters indicate significant differences between days (P < 0.05)

Multiparous animals exhibited greater concentrations ($P < 0.01$) of triglycerides and VLDL than primiparous cows (Table 3). Furthermore, there was an interaction effect between sampling day and parity order ($P < 0.04$) for NEFA concentrations, with multiparous animals having greater concentrations than primiparous animals at parturition (Figure 3). Indeed, Cattaneo et al. (2023) found a greater apparent amount of adipose tissue mobilization in the second lactation compared to the first lactation in dairy cattle. Because milk yield is higher in multiparous cows, their nutrient demands during early lactation were likely greater than those of primiparous cows. Thus, they are more affected by the reduction in feed intake in the peripartum period. NEFA levels were similar between parity orders during postpartum period, which agrees with the similarity observed for BCS. Furthermore, the greater NEFA concentrations at parturition in multiparous cows explain the higher blood concentrations of VLDL in this category. Very low-density lipoproteins play an important role in the transport of triglycerides synthesized in the liver to peripheral tissues, including mammary gland (Puppione, 1978), which also supports the greater fat yield of milk observed in multiparous cows.

Table 3
Effects of parity and supplementation on metabolite and hormone concentrations

Item	Treatment[1]				SEM	P-value[2]					
	UP1	SP1	UP2	SP2		S	D	S×D	P	P×S	P×D
Glucose, mg dL^{-1}	69.9	60.4	69.3	70.4	4.60	0.25	<0.01	0.94	0.18	0.14	0.26
Triglycerides, mg dL^{-1}	20.8	22.7	23.6	24.5	0.56	0.25	0.24	0.52	0.01	0.84	0.33
Total cholesterol, mg dL^{-1}	139	129	143	126	3.18	<0.01	<0.01	0.71	0.70	0.21	0.23
NEFA, mmol L^{-1}	0.24	0.21	0.20	0.27	0.62	0.10	<0.01	0.24	0.49	0.15	0.026
LDL, mg/dL^{-1}	57.3	51.7	58.2	47.0	2.63	0.02	<0.01	0.32	0.37	0.83	0.14
HDL, mg/dL^{-1}	76.0	79.6	79.5	77.0	1.31	0.53	<0.01	0.29	0.37	0.66	0.51
IGF-1, ng/mL^{-1}	220	244	222	249	10.8	<0.01	0.47	0.26	0.44	0.26	0.33
SUN, mg/dL^{-1}	11.3	11.5	12.3	11.2	1.01	0.70	<0.01	0.38	0.82	0.32	0.31
Total proteins g/dL^{-1}	6.28	6.18	6.59	6.60	0.15	0.73	<0.01	0.57	0.82	0.32	0.32
Albumin, g/dL^{-1}	3.04b	3.13a	3.28a	3.17a	0.08	0.70	<0.01	0.77	<0.01	0.04	0.24
Globulins, g/dL^{-1}	3.24	3.05	3.31	3.43	0.07	0.98	<0.01	0.64	0.02	0.14	0.32
VLDL	4.15	4.55	4.73	4.91	0.11	0.25	0.24	0.52	0.01	0.84	0.33

[1]Unsupplemented primiparous (**UP1**), supplemented primiparous (**SP1**), unsupplemented multiparous (**UP2**), and unsupplemented multiparous (**SP2**). [2]S: supplementation effect; D: sampling day effect ; S × D: interaction effect between sampling day and supplementation; P: parity effect; P × S: interaction effect between parity and supplementation; P × D: interaction effect between parity and sampling day; SEM: standard error of the mean; βHB: beta-hydroxybutyrate*; NEFA: non-esterified fatty acids; IGF-1: insulin-like growth factor; SUN: serum urea nitrogen; LDL: low-density lipoprotein; HDL: high-density lipoprotein; VLDL: very low-density lipoprotein;

There was an effect of sampling day (*P* < 0.01) on glucose and SUN concentrations. Indeed, previous studies with Nellore cows have consistently reported elevated glucose levels at calving, regardless of supplementation (Ferreira et al., 2020). This increase is associated with the hormonal response (e.g., cortisol and epinephrine) to the stress of calving. These hormones stimulate the release of amino acids and glycerol from muscle and adipose tissue, respectively, which in turn promotes gluconeogenesis (Ralph & Tilbrook, 2016). This catabolic process may also explain the elevated blood urea nitrogen and NEFA levels observed at calving. Furthermore, feed intake decreases near parturition in grazing Zebu cows and appears to remain reduced during the first days of lactation (David et al., 2024), potentially intensifying tissue mobilization during early lactation.

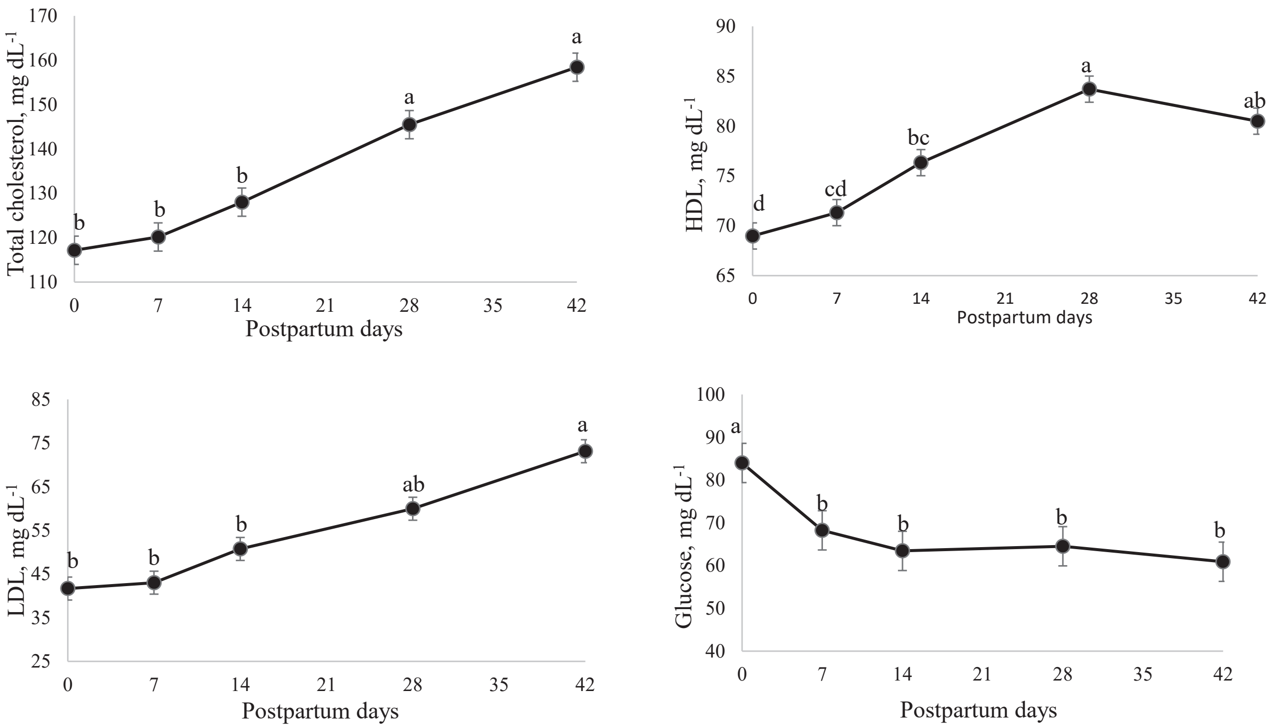

Figure 2. Postpartum blood concentrations of serum total cholesterol, HDL, LDL, and glucose in grazing beef cows on tropical pasture. Different letters indicate significant differences between days (P < 0.05)

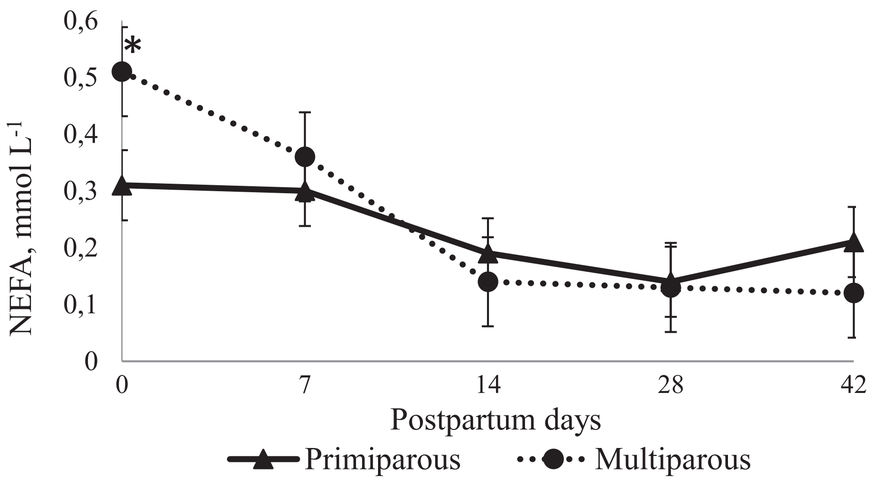

Figure 3. Postpartum blood concentrations of non-esterified fatty acids (NEFA) in primiparous and multiparous beef cows on tropical pasture. Numbers followed by asterisks (*) are significantly different between parity classes (P < 0.05).

Sampling day affected total cholesterol, HDL and LDL concentrations (*P* < 0.01), with values increasing throughout lactation. This response may be explained by the recovery of feed intake (David et al., 2024), as well as by the increasing metabolic demand for cholesterol during the re-establishment of reproductive activity (Holtenius et al., 2003). Cholesterol is the main precursor for steroid hormone synthesis, and HDL plays an important role in cholesterol transport to ovarian tissues. Indeed, granulosa cells primarily acquire cholesterol through HDL uptake (Shalgi et al., 1973), which may partially explain the gradual increase in circulating HDL concentrations over time.

Conclusion

Postpartum supplementation improves the productive performance of grazing Nellore cows, regardless of parity. Overall, primiparous and multiparous cows exhibit similar metabolic adaptations during early lactation. However, multiparous cows show greater lipid mobilization around parturition. Unsupplemented primiparous cows exhibit poorer protein metabolic status, indicating that this category may be more sensitive to inadequate nutrient supply during the postpartum period.

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