

Performance of calves in dry season feedlot according to genetic group and sex

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ABSTRACT - The aim of this study was to evaluate feedlot rearing as a strategy for beef calves during the dry season and to assess the effects of genetic group and sex on productive performance. Fifty-four calves were allocated to a completely randomized design with a 3 × 2 factorial arrangement, consisting of three genetic groups (Caracu, Nellore, and Caracu × Nellore crossbred) and two sex classes. The diet was formulated to support an average daily gain (ADG) of 0.5 kg/day. Average daily gain (ADG), dry matter intake (DMI), and feed conversion ratio (FCR) were evaluated. Data were analyzed by analysis of variance, and means were compared using the Student-Newman-Keuls test at 5% significance level. A significant interaction between genetic group and sex was observed for ADG ($P < 0.05$). Crossbred Caracu × Nellore males showed the highest ADG (0.75 kg/day), differing from all other treatment combinations. Caracu males and Caracu × Nellore females showed intermediate ADG values and did not differ from each other, while Nellore males and females exhibited the lowest gains and did not differ between sexes. No interaction was detected for DMI or FCR ($P > 0.05$); however, significant main effects of genetic group and sex were observed. Caracu and Caracu × Nellore calves showed greater DMI than Nellore calves, and males consumed more dry matter than females. A better feed conversion was observed in crossbred calves, followed by Caracu and Nellore calves, and males showed greater feed efficiency than females. Feedlot rearing during the dry season proved to be an effective strategy for promoting satisfactory growth rates in beef calves. Under the conditions of this study, crossbred Caracu × Nellore calves and males exhibited superior performance and feed efficiency, highlighting the importance of considering both genetic group and sex when allocating calves to intensive post-weaning systems.

Keywords: intensive rearing, nutritional strategy, seed straw

1. Introduction

The rearing phase of beef calves in tropical regions coincides with the dry season, which is characterized by poor-quality pastures. The decline in pasture quality during this period, combined with dietary

changes associated with weaning, results in an inadequate nutrient supply, thereby compromising calf performance (Poppi et al., 2018; Nishimura et al., 2023). To alleviate the challenges of this phase, one strategy used is to confine calves during the rearing phase in dry seasons.

The practice of rearing calves in feedlots is used in beef cattle farming as an alternative strategy to reduce costs and improve the management of short-cycle beef cattle farming. In addition to favoring animal performance, this technique allows for the recovery of pastures (Pereira et al., 2020) and supports a production cycle that enables the slaughter of younger individuals (Nascimento, 2021), resulting in higher carcass yield and better meat quality (Sampaio et al., 2017; Roth et al., 2019), while also promoting greater market activity and increasing competitiveness through an expanded beef supply.

Among the key factors influencing post-weaning performance in beef calves are genetic group and sex, which affect physiological parameters such as dry matter intake, average daily gain, and feed conversion ratio (Bureš and Bartoň, 2012; Daza et al., 2014). In feedlot systems, nutritional management aims to optimize these variables through precise dietary adjustments, creating conditions that ensure an adequate nutrient supply and allow calves to achieve their growth potential according to their genetic and physiological traits. Consequently, decisions regarding the viability of feedlot systems for growing calves should be based on performance indicators combined with an economic evaluation. Previous studies have demonstrated that Caracu cattle, a tropically adapted taurine breed, exhibit superior feed efficiency, early maturity, and greater voluntary intake compared with Zebu breeds such as Nellore (Euclides Filho et al., 2003). Crossbreeding between Caracu and Nellore combines adaptability with improved growth performance through heterosis, particularly in feedlot systems. These genetic interactions can influence growth patterns, nutrient utilization, and economic outcomes of feedlot systems for growing calves.

When raising beef cattle in tropical environments, characterized by nutritionally poor-quality pastures during the dry season (Fraga et al., 2003; McManus et al., 2009), it is essential to work with breeds that are already adapted to these conditions. In this context, the Nellore and Caracu breeds stand out due to their adaptability, hardiness and carcass yield. In addition, animals resulting from crossbreeding between these breeds also present satisfactory production rates, since maximum heterosis, resulting from the crossing of the two pure breeds, allows offspring to outperform the average performance of the parental breeds. In addition to genetic background, sex-related hormonal differences are also responsible for variations in performance, growth, fat deposition and carcass structure (Berg and Butterfield, 1976). Our hypothesis was that crossbred calves would exhibit superior productive performance compared with purebred animals and that intact males would outperform females. Thus, our objective was to evaluate the effect of sex and genetic group on the productive performance of beef calves subjected to feedlot rearing after weaning during the dry season.

2. Material and methods

2.1. Experimental conditions, animals and analyzes

The experiment was carried out on Pedra Redonda Farm, in the municipality of Ritópolis-MG, Brazil. Located at the following coordinates: 20°59'49.80" S and 44°23'52.41" W. Fifty-four calves (uncastrated males and females) aged 7 ± 1 months were used. The average initial body weights were: Caracu male: 191 ± 6 kg; Caracu female: 183 ± 8 ; Nellore male: 185 ± 9 ; Nellore female: 172 ± 12 ; crossbreed Caracu $\times$ Nellore male: 208 ± 9 and crossbreed Caracu $\times$ Nellore female: 194 ± 11 kg. Calves started the experimental protocol immediately after traditional weaning. There were 18 calves (nine males and nine females) from each genetic group (Caracu, Nellore and crossbred Caracu $\times$ Nellore).

The genetic group and sex were distributed in a completely randomized design, in a 3×2 factorial (three genetic groups, two sexual classes), being: T1: Caracu male; T2: Caracu female; T3: Nellore male; T4: Nellore female; T5: Caracu $\times$ Nellore crossbreed male and T6: Caracu $\times$ Nellore crossbreed female.

The calves were housed in 18 collective pens, with 15 m² per calf. Three calves of the same genetic group and sex were housed in each pen equipped with feeders with 1 linear meter/calf and drinking troughs.

All calves received the same diet, formulated to meet the requirements of an animal with a body weight of 200 kg and an expected gain of 0.5 kg/day, in accordance with the NASEM recommendations (NASEM, 2016). The roughage was waste from forage seeds crop (*Urochloa brizantha* cv. MG4), processed industrially. This waste is made up of stems, leaves and remains of inflorescences, which are finely ground and, through pressure and temperature, are densified in the form of "briquettes" (briquettes of hay - Briqfeno®). Corn bran, soybean meal, urea and premix made up the concentrate. The chemical composition of the diet and its components are presented in Table 1.

The animals had a 21-day adaptation period to the diet. Only then did the 90-day experimental period begin. Weighings were performed every 30 days. The diet consisted of 66% processed seed residue (hay briquettes) and 34% concentrate. It was offered *ad libitum* to the calves, and an adjustment was made each week so that 5% of the amount offered remained in the trough. The diet was fed to the calves in two daily meals (one at 8:00 am and the other at 3:00 pm). The leftovers were collected and weighed the next day in the morning.

Samples of the ingredients and the total mixed ration and leftovers were collected to determine the dry matter (DM) and crude protein (CP) according to the AOAC methodology (AOAC, 1990). Total digestible nutrients (TDN) were estimated according to the equation proposed by Weiss et al. (1992) and the neutral detergent fiber was estimated according to AOAC methodology (NDF; method AOAC 2002.04).

The body weight gain in the period was obtained by the difference between the initial and final body weight of each animal, and the average daily gain (kg/calf/day) was calculated using the following formula: (Final weight – Initial weight)/90 days. The dry matter intake by the animals was determined by the difference between the amount offered and the leftovers from each pen with three animals. Feed conversion ratio was obtained by follows: FCR = feed given/body weight gain, both in kg/day.

Table 1 - Chemical composition of the concentrate, roughage and diet

Item	DM (g/kg)	CP (g/kg)	TDN (g/kg)	aNDFmo (g/kg)
Concentrate	913	220	780	131
Roughage	918	50.5	450	735
Diet (total mixed ration)	916	108	562	530

DM - dry matter; CP - crude protein; TDN - total nutrients digestive (estimate); aNDFmo - neutral detergent fiber.

2.2. Statistical analysis

The experimental unit considered in the statistical model was the pen, with each pen housing three calves of the same genetic group and sex. Thus, all measurements (e.g., dry matter intake, feed conversion, average daily gain) were analyzed at the pen level, ensuring statistical independence of the observations.

The design was a 3 × 2 factorial in completely randomized design, considering the fixed effects of genetic group, sex and their interaction. The random effect was the experimental error associated with the pen. The statistical models were as follows:

$$y_{ijk} = \mu + \alpha_i + \tau_j + \alpha\tau_{ij} + e_{ijk},$$

in which y_{ijk} is the response variable for the i -th genetic group in the j -th sex in the k -th repetition, μ represents the unknown population mean, α_i is the effect of factor genetic group, τ_j is the effect of factor sex, $\alpha\tau_{ij}$ represents the interaction of the two factors and e_{ijk} is the independent errors.

The data was subjected to analysis of variance and, when significant, comparisons between means were performed using the Student-Newman-Keuls (SNK) test at a 5% level of significance. The assumptions of normality of residuals and homogeneity of variances were tested by Shapiro-Wilk. No extreme outliers with statistical impact were identified, but the presence of outliers was assessed by the interquartile boxplot criterion, and there were no data exclusions.

2.3. Economic assessment

An evaluation of the cost per kg of calf produced was carried out depending on the cost of the diet, food intake (as feed) and feed conversion of calves of different genetic groups and sex. For food cost composition, the price of each ingredient, the inclusion of the ingredient in the diet and the intake were used.

The cost of diet per calf/day was obtained using the following formula: $FI \times FC$, in which FI = food intake and FC = food cost. Multiplying the daily cost of food calf by 90 days, the cost/calf in the experimental period was obtained.

The calculation of the diet cost per kg of weight gained for the genetic group and sex was obtained as follows: Diet cost per calf (of each genetic group and each sex) in the period/Weight gain per calf in the period.

To calculate the cost of food, the prices for corn and soybean meal in July 2023, data made available by CEPEA/ESALQ/USP was considered. The prices of premix, urea and briquettes of hay were those purchased for the experiment. All prices are calculated in Brazilian currency BRL. For international comparability, economic values were also expressed in US dollars (USD). Currency conversion was performed using the average exchange rate of July 2023 (1 BRL = 0.20852 USD). All values originally calculated in Brazilian Reais (BRL) were converted to USD based on this rate.

Feed costs were calculated using as-fed intake, since ingredients are commercially traded on an as-fed basis. Dry matter values provided earlier are presented solely for zootechnical interpretation (e.g., dry matter intake – DMI) and do not affect feed cost or cost per kilogram of gain.

3. Results

A significant interaction between genetic group and sex was observed for average daily gain (ADG) ($P < 0.05$). Therefore, ADG results are presented according to the combined effects of genetic group and sex. In contrast, no significant interaction was detected for dry matter intake (DMI) or feed conversion ratio (FCR) ($P > 0.05$); thus, these variables are presented based on their main effects.

Average daily gain was influenced by the interaction between genetic group and sex ($P < 0.05$; Table 2). Crossbred Caracu $\times$ Nellore males showed the highest ADG (0.75 kg/day), differing from all other treatment combinations. Caracu males and Caracu $\times$ Nellore females did not differ from each other and showed higher ADG than Caracu females. Nellore males and females exhibited the lowest ADG values and did not differ between sexes ($P > 0.05$).

Table 2 - Average daily gain (ADG, kg/day) of calves according to genetic group and sex class during the 90-day confinement period

Genetic group	Female (mean $\pm$ SEM)	Male (mean $\pm$ SEM)
Nellore	0.38d $\pm$ 0.015	0.42d $\pm$ 0.017
Caracu	0.52c $\pm$ 0.024	0.66b $\pm$ 0.027
F1: Caracu $\times$ Nellore	0.63b $\pm$ 0.031	0.75a $\pm$ 0.027

Means followed by different letters differ significantly by Student-Newman-Keuls test ($P < 0.05$).

P-value (genetic group) < 0.01 .

P-value (sex) < 0.01 .

P-value (genetic group $\times$ sex) = 0.04.

No interaction between genetic group and sex was observed for DMI ($P > 0.05$). However, significant main effects of genetic group ($P < 0.05$) and sex ($P < 0.05$) were detected (Table 3). Caracu calves and those from Caracu $\times$ Nellore crossbreeding did not differ from each other ($P = 0.08$) and showed higher dry matter intake than Nellore calves. Regardless of genetic group, males consumed more dry matter than females.

Feed conversion ratio was not affected by the interaction between genetic group and sex ($P > 0.05$). Significant main effects of genetic group ($P < 0.05$) and sex ($P < 0.05$) were observed (Table 4). Crossbred Caracu $\times$ Nellore calves exhibited the best feed conversion, followed by Caracu calves, whereas Nellore calves showed the poorest FCR. Across genetic groups, males displayed better feed conversion than females.

Table 3 - Dry matter intake (DMI), followed by confidence intervals (CI 95%), during 90 days of the experiment according to the genetic group and sex of the calves

Item	DMI (kg/calf/day)	(CI 95%)
Genetic group		
Nellore	5.91b $\pm$ 0.092	(5.63-6.20)
Caracu	6.43a $\pm$ 0.143	(6.18-6.68)
F1: Caracu $\times$ Nellore	6.80a $\pm$ 0.162	(6.47-7.13)
Sex		
Female	5.86b $\pm$ 0.096	(5.61-6.11)
Male	6.58a $\pm$ 0.101	(6.31-6.84)

Within column, values followed by different letters are significantly different ($P < 0.05$) by Newman-Keuls test.

P-value (genetic group) < 0.01 .

P-value (sex) < 0.01 .

P-value (genetic group $\times$ sex) = 0.83 (NS).

Table 4 - Feed conversion ratio (FCR), followed by confidence intervals (CI 95%), during 90 days of experiment according to genetic group and sex of calves

Item	FCR	(CI 95%)
Genetic group		
Nellore	14.95a $\pm$ 0.187	(14.43-15.47)
Caracu	11.16b $\pm$ 0.292	(10.46-11.86)
F1: Caracu $\times$ Nellore	9.83c $\pm$ 0.331	(9.32-10.34)
Sex		
Female	13.76a $\pm$ 0.196	(12.67-14.86)
Male	12.39b $\pm$ 0.207	(11.18-13.59)

FCR = DMI/ADG, both in kg.

Within column, values followed by different letters are significantly different ($P < 0.05$) by Newman-Keuls test.

P-value (genetic group) < 0.01 .

P-value (sex) < 0.01 .

P-value (genetic group $\times$ sex) = 0.56 (NS).

As all animals received the same diet, differences in feeding cost among genetic groups were due exclusively to differences in feed intake. Crossbred Caracu $\times$ Nellore calves showed the highest daily feeding cost, followed by Caracu and Nellore calves. Despite the higher daily feed cost, crossbred calves presented the lowest cost per kilogram of body weight gain, reflecting their superior feed efficiency (Table 5).

Table 5 - Daily feed intake on an as-fed basis, body weight gain, daily feed cost, total feed cost, and cost per kilogram of body weight gain according to genetic group and sex

Item	As-fed intake (kg/calf/day)	Body weight gain (kg)	Calf diet cost (BRL/day)	Calf diet cost (USD/day)	Calf diet cost/period (BRL/90 days)	Calf diet cost/period (USD/90 days)	Cost of gain (BRL/kg of BW)	Cost of gain (USD/kg of BW)
Genetic group								
Nellore	6.45	36.9	7.28	1.52	655.03	136.58	17.75	3.70
Caracu	7.02	52.2	7.92	1.65	712.66	148.59	13.65	2.85
F1: Caracu × Nellore	7.42	63.0	8.37	1.74	753.67	157.13	11.96	2.49
Sex								
Male	7.18	49.5	8.10	1.69	729.29	152.06	14.73	3.07
Female	6.39	41.4	7.22	1.51	649.49	135.42	15.69	3.27

4. Discussion

Generally, the greater weight gain of males compared with females is due to sexual dimorphism. Physiologically, this difference is related to the higher rate of protein deposition and lower fat accumulation in intact males (Purchas, 1991), a process stimulated by testosterone (Fletcher et al., 1986). Berg and Butterfield (1976) also noted that androgenic hormones affect the pattern, distribution, and composition of tissue growth, explaining the superior performance observed in uncastrated males. In the pre-pubertal phase, androgen concentrations are still low, and the pronounced hormonal effects observed in adulthood are not yet fully established. However, males tend to exhibit greater lean tissue deposition and a lower proportion of fat than females, due to sex-related intrinsic growth patterns.

In this study, the better performance of males was evident in the crossbred (Caracu × Nellore) and purebred Caracu groups, aligning with results reported by Gottschall et al. (2018) and Marcondes et al. (2008). However, no significant difference in weight gain was observed between male and female Nellore calves, which may be attributed to the late puberty typical of Zebu cattle (Cardoso, 1977). Since steroid hormones that influence growth differ in their effects between sexes and their influence becomes more pronounced after puberty, the similar performance between sexes in Nellore calves may reflect the prepubertal stage of these animals during the trial.

Interestingly, Caracu × Nellore crossbred females performed similarly to Caracu males and better than Nellore males. This pattern may be explained by the contribution of taurine genetics to growth potential and by heterosis, which is known to enhance early-life performance in crossbred cattle.

The observed interaction between genetic group and sex for average daily gain (ADG) reflects a multifactorial biological response. Caracu × Nellore crossbred males exhibited superior performance compared with pure Nellore males, with a difference of 0.33 kg/day, corresponding to a 78.6% increase. This magnitude exceeds the 20–40% improvement typically reported for crossbred cattle in feedlot systems (Euclides Filho et al., 2003). Such a response may be primarily attributed to heterosis, which promotes metabolic vigor, improved nutrient utilization, and greater feed efficiency, particularly during the early life stages. Heterosis effects on growth traits are known to be more pronounced in young animals and tend to decline as animals approach physiological maturity (Cundiff, 1970; Gregory and Cundiff, 1980; Koots et al., 1994). These combined mechanisms may help explain the amplified performance differences observed among genetic groups in the present study.

The lower performance of Nellore calves in this study is also consistent with previous research indicating that Zebu animals typically exhibit lower voluntary intake and slower growth compared with taurine or crossbred animals, especially when energy supply is limited (Rotta et al., 2009). Taurine breeds such as Caracu are known for higher intake motivation and better energy utilization, particularly under moderate dietary energy levels. The conservative intake behavior and slower maturity of the Nellore breed may explain their lower ADG and feed efficiency in this context.

Moreover, the average daily gain of 0.42 kg observed in purebred Nellore calves is in line with their dry matter intake and the energy density of the diet (~56% TDN). With an average intake of approximately 2.1% of body weight, the net energy intake supported gains between 0.4 and 0.5 kg/day, as predicted by the BR-CORTE model (Valadares Filho et al., 2016) for confined Zebu animals. This confirms the adequacy of the feeding strategy for this group, even under restricted energy conditions.

Several studies have confirmed the performance advantage of crossbred over pure Zebu animals in feedlot systems. Euclides Filho et al. (2003) reported ADG increases of 20–40% in Caracu × Nellore crossbreds compared with Nellore steers. These findings reinforce the benefits of incorporating adapted taurine breeds into tropical beef production systems aiming for early finishing.

The similar performance between Caracu × Nellore females and Caracu males likely reflect the combination of heterosis and the intrinsic growth characteristics typically associated with adapted taurine breeds, reflecting the ADG capacity of the crossbred females. The interaction observed between genetic group and sex for average daily gain (ADG) reflects a multifactorial biological response. The superior performance of intact crossbred (Caracu × Nellore) male calves is likely the result of a synergistic effect between heterosis and androgenic stimulation, which together enhance muscle deposition and growth efficiency. In this context, heterosis is associated with metabolic vigor and improved feed utilization, while the hormonal influence of intact males promotes greater protein accretion relative to fat (Fletcher et al., 1986; Purchas, 1991).

Interestingly, crossbred females showed a performance similar to Caracu males, which may be attributed the expression of hybrid vigor in crossbred females, even in the absence of the hormonal advantage present in males. This result reinforces the genetic contribution of taurine breeds adapted to tropical conditions, which have historically shown greater feed efficiency and resilience compared with zebu breeds such as Nellore (Fraga et al., 2003; McManus et al., 2009).

Therefore, the interaction effect highlights the importance of evaluating performance by considering the combined effects of genotype × sex rather than assessing these factors independently, thereby supporting more strategic decisions in breeding and finishing systems. Recognizing this interplay supports more efficient allocation of animals to intensive systems, especially during critical phases such as the post-weaning period in the dry season. In the context of tropical production systems, taurine breeds adapted to heat stress and their crossbreds often show greater feed efficiency and resilience than zebu breeds under certain nutritional conditions; however, this does not imply that Nellore cattle are unsuitable for intensive systems. Nellore is the predominant breed in Brazilian feedlots and performs well when dietary energy supply is adequate. Rather, these genotype-related differences highlight the importance of matching animals to nutritional environments so that each genetic group can express its growth potential efficiently.

Maximum heterosis resulting from crossing of two pure breeds improve the average performance of the parental breeds. The role of heterosis in improving the performance of beef cattle is well understood and reported in the literature (Perotto et al., 2000; Vaz et al., 2001; Leal et al., 2018; Mendonça et al., 2019). Restle et al. (2000) evaluated the performance during the growth phase of pure Charolais, Nellore and Charolais × Nellore crossbred animals outperformed the average of the two pure breeds. In contrast, Fernandes et al. (2004), post-weaned Nellore calves showed higher ADG than Caracu × Zebu crossbreds under feedlot conditions, which differs from the pattern observed in our study. Although the ADG of 0.70 kg/day for our Caracu × Nellore calves was numerically close to the values reported by Fernandes et al. (2004), the relative performance between breeds was reversed. This discrepancy may be related to differences in genetic composition, since their crossbreds were not exclusively Caracu × Nellore, combined with variability in management, diet composition, and environmental conditions, all of which can influence the expression of heterosis and growth potential.

One of the explanations for the greater dry matter intake by males may be the greater requirement of nutrients to support greater body weight gain compared with females (Bailey and Duff, 2005). This could be corroborated with the DMI and ADG found in this study. However, sex is not the only determining factor on DMI in beef cattle (NRC, 2000), since there are reports in the literature where no

differences were found in the DMI of males and females or even greater DMI in females. It seems that DMI is more closely linked to weight and body composition, which makes it challenging to compare DMI in the present study.

The greater DMI of Caracu calves compared with Nellore calves likely reflects the combination of two mechanisms. First, tropically adapted taurine breeds such as Caracu have higher net energy requirements for maintenance than zebu breeds, as documented in the BR-CORTE system (Valadares Filho et al., 2016) and classical metabolic evaluations comparing taurine and indicine cattle (Ferrell and Jenkins, 1985). Second, animals with higher growth potential exhibit greater voluntary intake, as predicted by NASEM (2016) nutrient requirement models and decision-support simulations (Tedeschi et al., 2004). Consistent with these principles, Caracu and Caracu × Nellore calves have been shown to consume more feed and express superior growth compared with Nellore calves (Euclides Filho et al., 2003), supporting the interpretation that both maintenance energy requirements and growth potential contributed to the higher DMI observed in the present study.

Regardless of sex or genetic group, the dry matter intake was higher than the predicted (5 kg/calf/day), which can be attributed to the characteristics of the roughage used. Due to the smaller particle size of the hay briquettes (due to the fine grinding of the hay for the briquetting process), its passage rate through the rumen is accelerated, resulting in greater DMI.

Regarding feed conversion, males required a smaller amount of feed ingested on a dry matter basis to obtain 1 kg of live weight gain. Other authors have also demonstrated a better conversion for males compared with females (Santos, 2014). This result can be attributed to factors related to the composition of the gain, as males deposit a greater proportion of muscle tissue than females, especially in of growth performance in which the animals were in this study (Lanna, 1997).

For genetic groups, when relating gain to feed intake, it was found that crossbred animals showed greater efficiency compared with Caracu animals. Although both groups had similar DMI, crossbred calves converted more dry matter into body weight, which is justified by the greater ADG of crossbred cattle in the present study. Permigiani (2018) evaluated feed efficiency in genetic groups: *Bos taurus*, zebu and adapted taurine with an average age of 8±2 months and reported greater feed efficiency for *Bos taurus* followed, respectively, by adapted taurine and zebu. These results are consistent with ours, evidencing the superiority of Caracus (adapted breed) in relation to Nellore.

Despite the lower dry matter intake by females, the cost per body weight gain was higher, at R\$ 15.69/kg (USD 3.27/kg) of gain, while for males this cost was R\$ 14.63 (USD 3.07/kg). This difference in cost per kg of body weight gain is reflected in profitability, giving an advantage to confinement of males.

For the genetic groups, we observed that crossbred calves had the highest daily cost with the diet (R\$ 8.37; USD 1.74/day). This was due to consumption, however, statistically the Caracu and crossbred calves did not differ in this regard. Therefore, it is possible to infer that the crossbred calves demonstrated a better relationship between cost and weight gain, since they also presented better feed conversion. On the other hand, although the cost of feeding Nellore calves was the cheapest, due to the lower dry matter consumption per day, they had lower weight gain, as a result of the lower feed conversion.

Considering the feedlot strategy for rearing in the dry season in tropical climates, the ADGs were satisfactory. They were higher than the average gains obtained in rearing calves grazing during the dry season receiving protein supplementation with an intake of 1 g/kg of body weight. Evangelista et al. (2020) reported an ADG of 0.316 kg and Cordeiro et al. (2022) an ADG of 0.182 kg. Feedlot at the beginning of the rearing phase can be an alternative to enable greater gains during this period, which coincides with low forage availability (dry season). It is also a strategy to shorten the production cycle through increasing of performance.

Efficient rearing during the dry season eliminates the need for compensatory gain during the wet season. Compensatory gain in beef cattle is not always effective, since a considerable proportion

of the additional weight gain is associated with the growth of internal organs and viscera rather than carcass tissue. In addition, the feedlot during the rearing phase can result in an increase in carcass gain and better performance of the animals during the finishing phase, as demonstrated by Nascimento (2021). However, it is essential that the nutritional plan after the first dry season that calves have experienced is designed to achieve greater weight gains (Roth et al., 2017). Therefore, adopting confinement during the dry season can reduce the time until slaughter and the age at first breeding of females, regardless of genetic group or sex.

5. Conclusions

Crossbred Caracu × Nellore male calves showed the highest average daily gain and better feed conversion, indicating a synergistic effect between heterosis and androgenic stimulation. Caracu calves performed similarly to crossbred females, reinforcing the genetic potential of this breed under tropical conditions. Feedlot management during the dry season proved to be an effective strategy to promote growth and optimize feed efficiency, particularly when using males and animals with taurine inheritance. These results support the strategic allocation of animals according to sex and genotype during critical post-weaning phases.

Data availability

The datasets generated during and/or analyzed during the current study are not publicly but are available from the corresponding author on reasonable request.

Author contributions

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Conflict of interest

The authors declare no conflict of interest.

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