Colegio de Postgraduados

Adaptation of calves in the transition from intensive to dual-purpose system during extreme drought

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ABSTRACT

Objective: Evaluate the adaptation of calves in the transition from intensive to dual-purpose system during extreme drought.

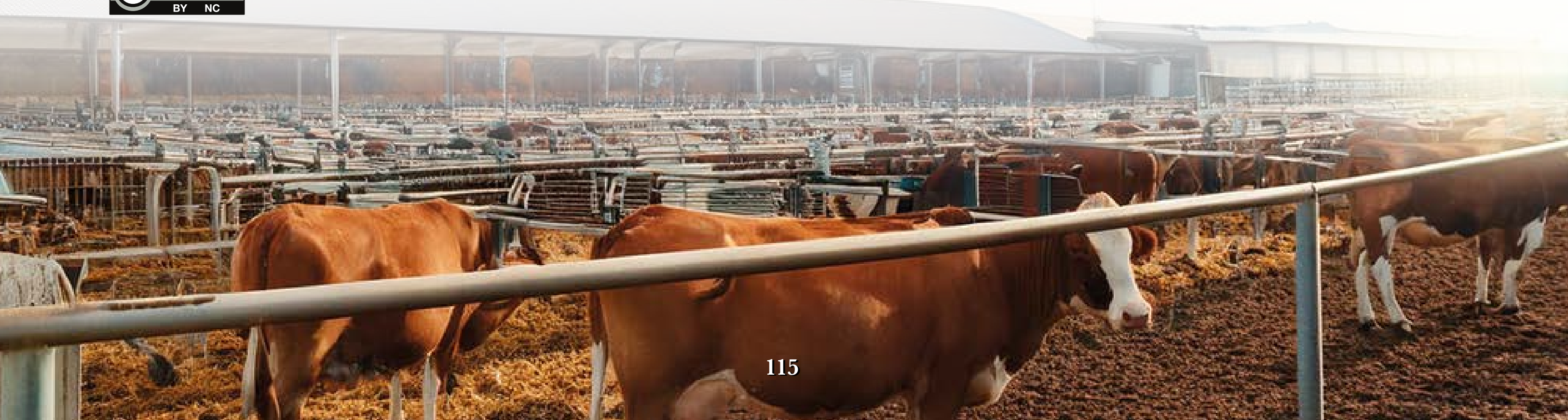
Design/methodology/approach: The study was carried out in Tamaulipas, Mexico with calves in transition from an Intensive Production System (IPS) in Ciudad Victoria to a Dual-Purpose System (DPS) located in Altamira. Two groups of Swiss×Gyr×Holstein cross calves were analyzed, control group (CG; n=8) born in DPS, and the adapted group coming from IPS (AG; n=6), zoometric measurements were recorded: height at the withers, length of the animal, chest circumference, pelvis length, pelvis width, height at the rump, body condition and weight, the blood concentration of b-hydroxybutyrates (BHB) and glucose were measured. An ANDEVA was carried out with a factorial design and a correlation analysis.

Results: There were differences between AG and CG ($P<0.01$), as well as in the date factor ($P<0.01$). Blood concentrations of BHB and glucose had no difference between groups ($P<0.05$). There was a negative correlation ($R=-0.47$; $P<0.05$) between BHB and body condition.

Limitations on study/implications: Although the dual-purpose system is very versatile, in the study area only 33% of ranchers manage it, due to the accentuation of drought and climate change.

Findings/conclusions: The calves showed adequate development with good adaptation in the transition from IPS to DPS, although there was an effect of the factors, the calves responded favorably to management.

Keywords: cattle, growth, zoometric measurements, betahydroxybutyrates.



INTRODUCTION

In cattle production units, an efficient system of raising calves for breeding is of great importance, which has a direct impact on future income and sustainability (Archbold *et al.*, 2012). The dual-purpose cattle system is characterized by having production units whose purpose is to produce milk and meat (Cuevas-Reyes y Rosales-Nieto, 2018). This production system is carried out by more than 60% of cattle farmers nationwide in Mexico due to its versatility (Noyola *et al.*, 2011). In addition, milk and meat production is not sufficient to meet the population's demand (Martínez-Alba *et al.*, 2021). The calves in these systems represent the future of cattle farms (González-Avalos *et al.*, 2017). In this regard, zoometry allows us to identify productive trends or zootechnical deficiencies, sexual dimorphism and morphometric comparison between breeds (Pardo-Bustamante, 2018). In bovine production systems it is important to look for alternatives, which makes the adaptation process of cattle from one system to another easier, for this reason, it is equally important to analyze the results obtained in body measurements during the adaptation process, for example, observing details such as the presence and maintenance of trees, which reduce high temperatures (Murgueitio *et al.*, 2014). The physiological and behavioral processes adopted by domestic animals in response to environmental changes are crucial for their survival (Neethirajan, 2020). The adaptation of calves from one production system to another is a process during which the animal is subjected to multiple physical and psychological stress factors, which impacts health and productive behavior (Larios-Cueto *et al.*, 2019). On the other hand, the stress level of an animal can be measured by parameters, using current technology sensors, such as: chemical, metabolic, physical and immunological compounds related to physiological adaptation in domestic animals (Neethirajan, 2020), for example, behavioural indicators have been used to assess the effect of stress caused by transporting livestock, pathological and physiological, in research on transport from the cattle finishing corral to the slaughterhouse (Werner *et al.*, 2013). However, the effects of drought stress can affect calf development, which has been little evaluated in dual-purpose systems. There are several factors that can cause stress to livestock in addition to transport, such as drought, high temperatures and lack of forage in the grasslands, some of the main indicators of stress in animals are changes in live weight, as well as the concentrations of glucose and free fatty acids (Larios-Cueto *et al.*, 2019). In this regard, ranchers must have several strategies to survive extreme drought, one of them is that you can sell a percentage of animals to cover the costs of supplementation and prevent high mortality rates (Peña-Cardozo *et al.*, 2023), another is the search for animal breeds more resistant to drought and heat (Chuncho *et al.*, 2013). Thus, the effects of stress caused by drought can affect the development of calves and have been little evaluated in cattle undergoing the transition from an intensive system (semi-dry climate) to dual-purpose (subhumid climate). Therefore the hypothesis of the present study was that the development based on zoometric measurements and blood concentrations of betahydroxybutyrates and glucose would be similar in the control group and the adaptation group. The objective was to evaluate the adaptation of calves in the transition from intensive to dual-purpose systems during extreme drought.

MATERIALS AND METHODS

Experimental design

The study was developed in the state of Tamaulipas during the period from April to September 2022, The growth of two groups of calves was monitored: 1) control group (CG) which were born in the Location 1) "Granja El Paraíso" in the municipality of Altamira and 2) adaptation group (AG) that at the beginning of the experiment were moved from the Location 2) Farm located in the municipality of Ciudad Victoria, to Location 1. The dates coincide with the period in which the region's dry period occurs and this year this drought was more pronounced (NADC, 2022), so the temperatures were high and the grasslands conditions were dry and with little forage.

Location and characteristics of the place

Location 1, which was the target production unit for both groups (CG and AG), it is located in the municipality of Altamira, at the coordinates 22° 45' northern latitude and 98° 05' west latitude, with an altitude of 164 meters above sea level. Its temperature range is from 22 to 26 °C and its annual rainfall is 900 to 1100 mm. It has a warm subhumid climate with summer rains and medium humidity, and its physiography is divided into Coastal Plain from the Northern Gulf of Mexico and Body of Water (INEGI, 2009a).

Location 2, these are where the calves in the AG come from, which is located between the coordinates 24° 00' and 23° 24' northern latitude and 99° 26' and 98° 57' west latitude, with an altitude of 200 y 2200 meters above sea level, with a temperature range of 16 to 24 °C and its annual rainfall is 400 to 1100 mm, whose climate is semi-warm subhumid with rains in summer, with less humidity, and its physiography is divided between the Sierra Madre Oriental and Coastal Plain from the Northern Gulf of Mexico (INEGI, 2009b).

Characteristics of production systems

In Location 1 there is the farm "El Paraíso", a cattle production unit with a Dual-Purpose System (DPS), which has manual milking, in a tandem milking parlor for two cows, drinking troughs supplied with water from prey, diet based on grazing on native and improved pastures, with supplementation of commercial concentrates during milking, ande calves stay with their mothers during milking.

The characteristics of Location 2 are as follows: It is an Intensive Production System (IPS) of cattle with a semi-automatic parallel milking system with four cows, drinking fountains with drinking water available, balanced diets served in a mixer-grinder trailer and artificial calf breeding.

Experimental units

Calves were of the breed Swiss×Gyr×Holstein in the stage of development and body growth, they were organized into two groups: The first group born in the destination DPS of the experiment was the CG (n=9), with aged 8.1 months, an average weight of 92.4 kg and body condition (BC) of 2.3, was measured on a scale of 1 to 5, where 1 is a thin animal and 5 a fat animal (Morales *et al.*, 2012). The second group AG (n=4), with aged 4.5 months, an average weight of 101.7 kg and BC of 2.9.

Management and preventive medicine

The diet of both groups consisted of supplementation with 0.3 kg of commercial starter in calves concentrate (17.5% of Crude Protein) per animal per day; sorghum silage, ground sorghum forage, and minerals *ad libitum*. As a preventive medicine, the 8-way polyvalent vaccine was applied (Pasteurellosis and Clostridiasis). Internal deworming was performed with macrocyclic lactones (ivermectin) and benzimidazoles (fenbendazole), for external deworming and prevention of ectoparasites phenylpyrazolones (fipronil), and the organophosphate group (coumaphos).

Measurement of parameters and zoometry

Nine parameters were taken from the calves, which were: weight (W), calculated weight (CLW), body condition (BC), in addition to zoometric measurements: bovine length (BL), thoracic perimeter (TP), height at dorsal withers (HDW), pelvic length (PL), pelvic width (PW) and height rump (HR). These were measured in cm using a flexible tape measure. Likewise, the W was recorded in kg, using a mechanical livestock scale (capacity of 2,000 kg), CLW was obtained based on the formula TP×TP×BL/10838. The variables were evaluated biweekly. Regarding daily weight gain (DWG), it was obtained by the following formula:

$$DWG = \left(Inicial\ weight - final\ weight\right) / 68\, days$$

Blood sampling

Blood concentration of β-hidroxibutirato (BHB) and glucose were measured monthly, by extracting venous blood from the jugular vein, with syringes for insulin administration. Blood concentrations of BHB and glucose were obtained from each animal two hours before feeding in the manger for both groups AG y CG (Goetz *et al.*, 2023). Blood samples to assess blood concentration of BHB in mmol L^{-1} and glucose in mg dL^{-1} were placed and made into strips (lancets) to obtain the readings of each metabolite electronically on a portable device (FreeStyle Optiurn Neo, Witney UK). All of the above was carried out with the necessary measures of controlled animal welfare (Deelen *et al.*, 2016).

Statistical analysis

The data was recorded and organized in a database. The homogeneity of variance of the data was confirmed and normality was confirmed with the test of Shapiro-Wilk. An ANDEVA with factorial design was performed for each variable, in which the dependent variables were W, CLW, BC, BL, TP, HDW, PL, PW and HR, for each of them there were two independent variables, which were the factors Date and Group. In the case of the Date, there were seven levels: 1) 17 may, 2) 24 may, 3) 05 june, 4) 14 june, 5) 28 june, 6) 08 july and 7) 19 july, and in the case of real weight logistics allowed only five levels: 1) 17 may, 2) 05 june, 3) 21 june, 4) 06 july and 5) 26 july. In the case of the factor Group, were two levels: 1) CG and 2) AG. The initial measurement of each dependent variable was included as a covariate and first-order interactions were considered. Regarding DWG, it was analyzed using the T-Student test, for analysis of blood concentrations of BHB an

Analysis of variance with factorial design was performed in which BHB were the dependent variable and the independent variables were the group factor with two levels 1) CG and 2) AG, and the measurement month factor with five levels: 1) May, 2) June, 3) July, 4) August, 5) September. First order interactions were considered. Regarding blood glucose concentrations, a variance analysis with a factorial design was performed in which the dependent variable was glucose and the factors were the group factor with two levels: 1) CG and 2) AG, and the month factor with three levels 1) May, 2) July and 3) September. First-order interactions were analyzed for this analysis. The correlation between BC and BHB was analyzed with the Pearson method. Statistical analyses were carried out in the statistical package Statgraphics Centurion edition XVI.

RESULTS

The AG dual-purpose calves adapted to the new production system and they had a favorable development to management, which was carried out as a preventive measure and continues to be monitored, zoometric measurements, W, DWG, blood concentrations of BHB and glucose were analyzed with the following results.

Zoometric measurements

For Factor A there were significant differences for W ($P=0.0070$), CG (99.9 kg) was higher than AG (96.2 kg), while for CLW ($P=0.0199$) CG (104.8 kg) was higher than AG (102.2 kg), in addition BL, PL and HDW were significant. For Factor B the W, CLW, LB, TP, HDW, PL, PW and HR were significant (Table 1). It is worth mentioning that for PW there were no differences in the group factor, but for the date factor ($P<0.05$), which may be influenced by the characteristics of the Swiss breed that predominates in the AG, there was no interaction effect between factors.

Daily weight gain

Regarding the DWG of the calves, there were significant differences between AG and CG ($P=0.0045$, Figure 1), considering a time of 68 days after the AG arrived at the farm receiving the animals, an DWG of 207.1 g was obtained in the CG and 18.4 g in the AG, which did not lose weight and managed to adapt to the new system.

Blood concentrations of betahydroxybutyrates (BHB)

Blood BHB concentrations were 0.23 mmol L^{-1} in AG and 0.30 mmol L^{-1} in CG in the month of May, 0.20 mmol L^{-1} in AG and 0.26 mmol L^{-1} in GC in the month of June, 0.33 mmol L^{-1} in AG and 0.40 mmol L^{-1} in CG in the month of July, 0.43 mmol L^{-1} in AG and 0.34 mmol L^{-1} in CG in the month of August, 0.28 mmol L^{-1} in AG and 0.29 mmol L^{-1} in CG in the month of September (Figure 2). The measurement month factor was significant ($P=0.0001$). Although, the group factor and the interaction were not significant ($P=0.2488$ and $P=0.1481$, respectively). However, there was a significant negative correlation ($R=-0.47$; $P<0.05$) between the variable blood concentration of BHB and body condition, which means, higher BHB concentration at lower body condition (Figure 3).

Table 1. Average zoometric measurements, weight and body condition of developing dual-purpose calves.

ANOVA	1°	2°	3°	4°	5°	6°	7°	8°	9°
Response variable	W (kg)	CLW (kg)	BC (1-5)	LB (cm)	TP (cm)	HDW (cm)	PL (cm)	PW (cm)	HR (cm)
CG	92.4	92.1	2.3	92.0	103.3	95.1	30.9	29.4	100.7
AG	101.7	99.8	2.9	95.0	104.5	95.0	30.7	25.5	102.7
CG	94.4	95.9	2.5	94.0	104.3	96.1	31.8	29.6	102.8
AG	101.7	101.9	2.8	95.5	105.5	96.7	31.0	25.7	104.2
CG	96.4	100.0	2.6	95.7	105.6	96.5	32.3	30.1	104.0
AG	104.0	107.6	2.9	97.0	107.7	97.0	31.5	26.7	105.2
CG	96.3	103.3	2.6	97.3	106.5	97.9	33.0	31.1	105.4
AG	101.2	109.2	2.8	98.2	108.0	97.7	32.2	28.0	106.7
CG	106.5	106.9	2.8	99.0	107.4	98.2	33.5	31.2	105.9
AG	103.0	110.8	2.9	98.2	109.0	97.7	32.2	28.5	107.2
CG		108.7	2.6	100.3	107.5	98.8	33.7	31.8	106.3
AG		111.6	2.4	98.2	109.3	98.5	32.5	29.5	107.2
CG		110.2	2.8	100.6	108.2	100.0	34.01	32.0	107.3
AG		112.3	2.2	98.5	109.5	98.5	32.5	30.2	107.7
Factor A Group	** 0.0070	* 0.0199	** 0.0004	** 0.0000	NS 0.2785	NS 0.5477	** 0.0004	NS 0.3869	** 0.0026
CG	99.9a	104.8a	2.7a	97.8a	106.5a	97.5a	32.4a	29.7a	105.3a
AG	96.2b	102.2b	2.4b	95.3b	107.0a	97.3a	31.5b	30.0a	104.3b
Factor B Date (D)	** 0.0033	** 0.0000	NS 0.1046	** 0.0000	** 0.0000	** 0.0000	** 0.0000	** 0.0000	** 0.0000
D1	95.4b	94.4d	2.5a	93.0d	103.7c	95.0c	30.8c	28.1d	101.2d
D2	96.4b	97.6cd	2.6a	94.2cd	104.7bc	96.5bc	31.4c	28.3cd	103.1c
D3	98.4ab	102.3bc	2.7a	95.7bc	106.5ab	96.7b	31.9bc	29.0bcd	104.2bc
D4	97.1b	104.7ab	2.6a	97.2ab	107.0ab	97.8ab	32.7ab	30.2abc	105.6ab
D5	103.1a	107.3ab	2.7a	98.1ab	108.0a	98.0ab	32.8ab	30.5ab	106.2a
D6		108.7.1a	2.4a	98.7a	108.3a	98.7a	33.1ab	31.2a	106.4a
D7		109.6a	2.4a	99.0a	108.6a	99.3a	33.2a	31.8a	107.1a
Average	98.1	103.5	2.5	96.6	106.7	97.4	32.3	29.9	104.8
CVRT	P In ** 0.0000	P Cal In ** 0.0000	CC In ** 0.0000	L In ** 0.0000	PT In ** 0.0000	AC In ** 0.0000	LP In ** 0.0000	AP In ** 0.0000	AG In ** 0.0000
Int AB	* 0.0183	NS 0.7580	** 0.0067	* 0.0159	NS 0.9957	NS 0.4589	NS 0.7634	NS 0.6163	NS 0.8839

CG: control group (n=9); AG: adaptation group (n=4), W: weight, CLW: calculated weight, BC: body condition, BL: bovine length, TP: thoracic perimeter, HDW: height at dorsal withers, PL: pelvic length, PW: pelvic width, HR: height rump; In: initial **: highly significant ($P<0.01$); *: significant ($P<0.05$); NS: not significant. Literal different denotes significant difference Tukey ($P<0.05$) for each factor per column; CVRT: Covariate of the ANOVA; Int: interaction.

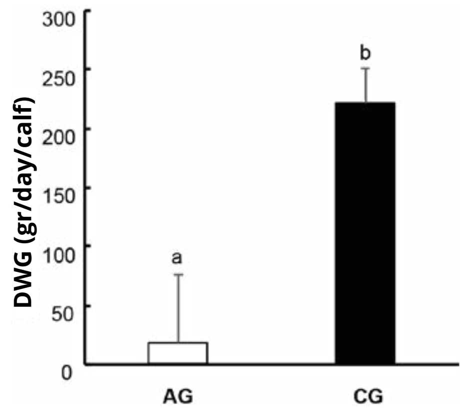


Figure 1. Daily weight gain (DWG) in developing calves of the adaptation group (AG □; n=4) from an intensive system to a dual-purpose system compared to those born in the herd as a control group (CG ■; n=9) during the months of greatest heat stress. Literals indicate significant difference between groups (P<0.05).

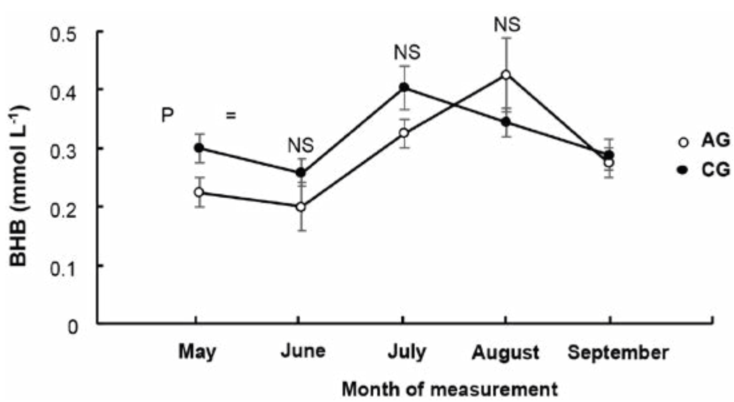


Figure 2. Mean ± SE of blood BHB concentrations over time in developing calves from the adaptation group (AG ○; n=4) from an intensive system to a dual-purpose system compared to those born in the herd as a control group (CG ●; n=9) during the months of greatest heat stress. NS: not significant difference.

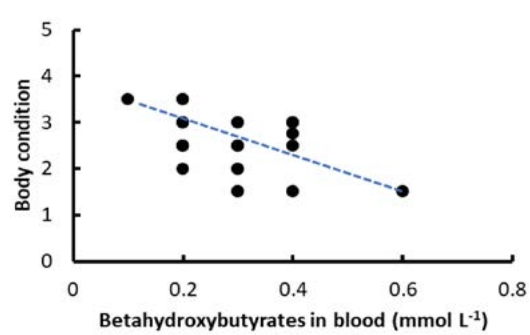


Figure 3. Correlation of body condition with blood concentration of β-hidroxibutirato in dual purpose calves (R=−0.47; P<0.05).

Blood glucose concentrations

Blood glucose concentrations were 49.0 mg dL^{-1} in AG and 58.7 mg dL^{-1} in CG in the month of May, 48.5 mg dL^{-1} in AG and 55.8 mg dL^{-1} in CG in the month of July, 46.3

mg dL^{-1} in AG and 52.3 mg dL^{-1} in CG in the month of August (Figure 4). The group factor was significant (P=0.0070). However, the factor month of measurement and the interaction were not significant (P=0.3866 y P=0.8537, respectively).

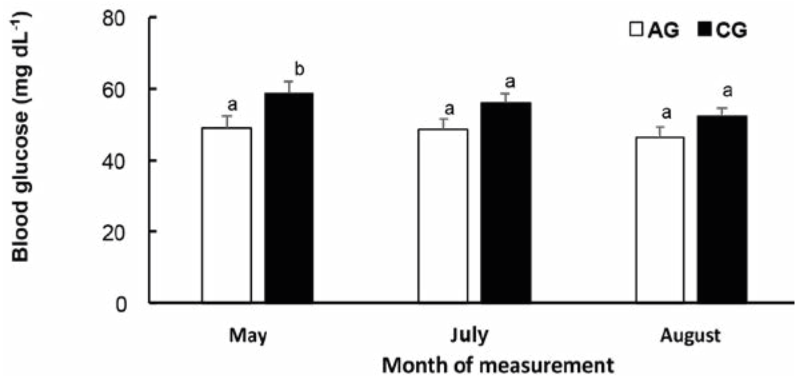


Figure 4. Mean ± SE of blood glucose concentrations over time in developing calves from the adaptation group (AG □; n=4) from an intensive system to a dual-purpose system compared to those born in the herd as a control group (CG ■; n=9) during the months of greatest heat stress. Different literals denote significant difference between groups of the study.

DISCUSSION

Favorable results were obtained in the development of calves from both CG and AG groups, because thanks to the supplementation and management that was given to them. They were able to get through the dry season in the best way, this is of great relevance because any farmer could use similar management and supplementation, since its costs are not high. In this regard, Larios-Cueto *et al.* (2019) mention that the response of animals to stress varies according to different factors, such as: transportation, grouping of unknown animals, new diet, management in the production unit, noise pollution, high population density, type of personnel and their way of caring for them, water conditions and forage quality, among others.

Zoometric measurements

Development based on zoometric measurements was continuous and adequate for the calves, with minimal supplementation of concentrate in addition to minerals *ad libitum* and adequate preventive management in both groups studied. Carrying out measurements on cattle allows monitoring them in order to establish selection processes that manage to maintain their breed condition, since zoometry is an important work element to define a population (Pineda, 2010). Salamanca *et al.* (2013) used 57 Casanare Creole bovine animals (49 cows and eight bulls) for which eight zoometric indices were calculated; the indices that presented significant statistical differences were compared with those of other breeds *Bos taurus* european, Creole and *Bos índicus* to establish some phenotypic differences with the Casanare Creole breed. Their results are similar to those of the present study because they found differences in their measurements in the pelvis and head, although it varies in the development and objectives of the study which compares the zoometric indices between bulls and cows for the purposes of rescue and conservation of the breed. In this regard, Salazar *et al.* (2010) confirmed that the thoracic perimeter is a good indicator of live weight in growing dual-purpose cattle, which can be used on farms that do not have a scale to estimate changes in the weight of animals, especially in animals that have been acquired from other states or climates, as was the case in the present study. Also other authors, Chavan *et al.* (2022) Based on the zoometric measurements obtained, they determined with different treatments (diets) in which the development of the Deoni heifers was superior. Therefore, it has been a useful measure since the beginning of technological advances and in management situations where the live weight of the animal cannot be determined, many other parameters can be measured to estimate it indirectly (Heinrichs *et al.*, 1992).

Daily weight gain

González-Avalos *et al.* (2017) worked with 120 lactating Holstein calves in Francisco I. Madero, Coahuila, Mexico. The calves were separated from their mother at birth and housed individually, fed with a milk replacer with 22% crude protein (CP), and weaned at 50 days of age, when they were already fed with a starter with 21.5% CP, following up for 65 days, in which they reported DWG of 415 to 614 g, results superior to those of the present study, which may be due to differences in the physiological stage in which lactation was included, as well as to the different management due to the intensive production system used in their study. Sandoval *et al.* (2005) studied 177 dual-purpose calves during their first three months of life in Veroes Yaracuy, Venezuela. Management was provided by separating the calves from their mother at birth and in collective housing, suckled by nurse cows, and grazed daily (star grass, *Cynodon plectostachyun*), supplemented with a daily sack of concentrated feed with 16% CP, with an average consumption per animal of 430 g daily. The authors report that the DWG was 190 to 460 g. De Menezes *et al.* (2015) experimented with 60 cows crossbred of ¼ Holstein and ¾ Zebu dual-purpose calves in Felixlandia, Brazil, with the aim of evaluating the effect of feeding strategies on the weaning weight of calves and milk production, consisting of restricted milk supply with corn and soybean concentrate supplementation with 26% CP and Brachiaria grass with six to 11% CP, starting the study at 90 days of age of the calves and evaluating the short milking period strategy of 180 days and normal of 270 days. Their results show DWG from 650 to 1120 g in the calf groups made up of seven males and five females each. Their results are higher than the DWG of this study, mainly due to the physiological stage measured during lactation, as well as the high CP diet, which increases the costs in this type of management.

Blood concentrations of betahydroxybutyrates (BHB)

The BHB levels and their relationship with energy balance have been studied in cattle since they increase as a result of catabolism and fat mobilization (Fenwick *et al.*, 2008). Calves depend on the mobilization of adipose tissue to cope with different environmental conditions, especially during drought, a season in which feed on pasture is scarce, so their dietary sources of energy can be compromised, which can lead to an increase in BHB, resulting in a negative energy balance (Goetz *et al.*, 2023). Deelen *et al.* (2016) conducted a study in Seaforth, Ontario, Canada, with twenty Holstein calves weaned at six and eight weeks of age, with the aim of determining blood BHB levels and their relationship with intake and rumen development, in addition to using the Precision Xtra test for BHB. They reported an association of BHB concentration with rumen volatile fatty acids, ruminal butyrate and with the live weight of the calves, with values ranging from 0 to 0.04 mmol L^{-1}, in addition to the fact that the test was effective and could be used to decide on sufficient intake of starter concentrate and ruminal development. The values found by the authors are similar to those of the present study although the age of the animals varies. This is surely due to the fact that in this case the calves did not have stress or negative energy balance. Goetz *et al*. (2023) worked in Seaforth, Ontario, Canada, with the aim of investigating the effects of transport duration and age at transport on blood parameters in 175 calves after 6, 12 and 16 h of road transport, BHB were higher after transport in calves transported for 12 h of 0.09 mmol L^{-1} BHB, and 16 h of 0.15 mmol L^{-1} BHB compared to calves transported for six hours of 0.05 mmol L^{-1} BHB, in addition, calves transported at older ages (seven to 14 days) had a higher concentration of BHB compared to calves aged two to six days, due to the greater amount of fat available in their body. Their results are greater than those in the present study, probably due to the stress and negative energy balance that the animals face when being transported, in addition to the fact that during this period they generally do not consume food, so it is inferred based on the results that the calves in the present study did not have this kind of stress.

Blood glucose concentrations

Avalos-Rosario *et al*. (2023) worked with the objective of identifying associations in body condition, glucose, BHB, and white blood cells in dual-purpose cows during the transition period in the tropics of Veracruz. They studied 30 multiparous cows, crossbred with *Bos taurus*×*Bos indicus*, which were grazed in an intensive rotation system, with grass, Brizanta (*Brachiaria brizantha*) and African Star (*Cynodon plectostachyus*), and orange pulp silage 10 kg/cow daily. The authors report an average blood glucose of 39.4 mg dL^{-1} in prepartum cows and 37.6 mg dL^{-1} in postpartum cows, in addition to a negative correlation between glucose and BHB levels, the lower the glucose concentration, the higher the BHB concentration ($r=0.51$). The authors conclude that low producing dual-purpose cows experienced fluctuations in body condition, BHB, and immune cell populations during the transition period, suggesting metabolic and immune changes similar to those in high producing dairy cows. The values are slightly lower than those of the present study, probably because adult cows were used, although the behavior of glucose in relation to BHB was negatively correlated, showing that the metabolism of both functioned in a similar way.

CONCLUSIONS

The adaptation of calves when moving between different production systems is of vital importance. The adaptation group of calves had lower body condition, weight and calculated weight; however, their development was adequate and they achieved growth because they were given good preventive medicine management and supplementation, allowing them to develop well during the dry season, reducing the mortality rate during that period. There were no differences in blood concentrations of betahydroxybutyrates and glucose in the groups of developing calves during the transition period from an intensive system to a dual-purpose system during the drought, indicating that they had good adaptation.

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