Performance and immune response of steers Nellore finished in feedlot and fed diets containing dry leaves of *Baccharis dracunculifolia*

Desempenho e resposta imune de novilhos Nelore terminados em confinamento e alimentados com dietas contendo folhas secas de *Baccharis dracunculifolia*

Rendimiento y respuesta inmune de novillos en confinamiento alimentados con inclusión de hojas secas de *Baccharis dracunculifolia* en su dieta

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Abstract
This study was carried out to investigate the effects of addition Baccharis dracunculifolia leaves in nature on animal performance, feed intake, ingestive behavior, and blood parameters of Nellore steers finished in feedlot on high-grain diets. A total of 40 Nellore steers, with an average body weight of 412.9 ± 22.0 kg were distributed in individual pens, equipped with automatic drinkers and masonry feeders. The steers were randomly assigned to one of four studied diets, therefore the CONT – basal diet; BAC05 – basal diet and inclusion of B. dracunculifolia leaves in natura (5 g/animal/day); BAC10 – basal diet and inclusion of B. dracunculifolia leaves in natura (10 g/animal/day); and BAC15 – basal diet and inclusion of B. dracunculifolia leaves in natura (15 g/animal/day). The use of plants in nature did not affect final body weight, average daily gain, dry matter intake, or feed efficiency. Neither on ingestive behavior activities and plasma concentrations of urea, creatine, aspartate aminotransferase, gamma-glutamyl transferase, and creatine kinase no effects were detected between diets. The inclusion of plants in nature in steer’s diet did not negatively impact performance and health. However, further field studies with beef cattle are needed for greater clarification of its effects and dosages.

Keywords: Beef cattle; High-grain diet; Ingestive behavior; Plasma metabolites.

Resumo
Este estudo foi realizado para investigar os efeitos da adição de folhas de Baccharis dracunculifolia in natura sobre o desempenho animal, ingestão de alimentos, comportamento ingestivo e parâmetros sanguíneos de novilhos nelore terminados em confinamento e alimentados com dietas de alto grãos. Um total de 40 novilhos Nelore, com peso corporal médio de 412.9 ± 22.0 kg foram distribuídos em baias individuais, equipadas com bebedouros automáticos e comedouros em alvenaria. Os novilhos foram alocados ao acaso e alimentados
com quatro diferentes dietas: CONT – dieta basal, BAC05 – dieta basal e inclusão de folhas de *B. dracunculifolia in natura* (5 g/animal/dia); BAC10 dieta basal e inclusão de folhas de *B. dracunculifolia in natura* (10 g/animal/dia) e BAC15 – dieta basal e inclusão de folhas de *B. dracunculifolia in natura* (15 g/animal/dia). O uso das folhas da planta da *B. dracunculifolia in natura* não alterou o peso final, ganho médio diário, ingestão de matéria seca e eficiência alimentar. Da mesma forma, as atividades do comportamento ingestivo, as concentrações de ureia, creatinina, aspartato amino transferase, gama glutamil transferase, creatinina quinase não foram alterados pelas dietas. Assim, a inclusão de folhas de planta *B. dracunculifolia in natura* na dieta de novilhos não teve impacto negativo no ganho em peso e saúde dos animais. No entanto, mais estudos de campo com bovinos de corte são necessários para maiores conhecimentos dos seus efeitos e dosagens a serem usadas.

**Palavras-chave:** Bovinos de corte; Dietas de alto grão; Comportamento ingestivo; Metabólitos plasmáticos.

**Resumen**

Este estudio se realizó para investigar los efectos de la adición de hojas de *Baccharis dracunculifolia in natura* en el desempeño animal, la ingestión de alimentos, comportamiento ingestivo y los parámetros sanguíneos de novillos Nellore terminados en cebaderos y alimentados con dietas altas en granos. con un peso corporal promedio de 412,9 ± 22,0 kg se distribuyeron en corrales individuales, equipados con bebederos automáticos y comederos en concreto. Los novillos fueron distribuidos aleatoriamente y alimentados con cuatro dietas diferentes: CONT - dieta basal, BAC05 - dieta basal e inclusión de hojas de *B. dracunculifolia in natura* (5 g/animal / día); BAC10 - dieta basal e inclusión de hojas de *B. dracunculifolia in natura* (10 g/animal/día) y BAC15 - dieta basal e inclusión de hojas de *B. dracunculifolia in natura* (15 g/animal/día). El uso de las hojas de la planta *B. dracunculifolia in natura* no alteró el peso final, la ganancia diaria promedio, la ingestión de materia seca y la eficiencia alimenticia. Asimismo, las actividades de comportamiento ingestivo, concentraciones de urea, creatinina, aspartato aminotransferasa, gamma glutamil transferasa, creatinina quinase no fueron alteradas por las dietas. Por tanto, la inclusión de hojas *in natura* de la planta *B. dracunculifolia* en la dieta de los novillos no tuvo un impacto negativo en la ganancia de peso y la salud de los animales. Sin embargo, se necesitan más estudios de campo con ganado de carne para comprender mejor sus efectos y las dosis a utilizar.

**Palabras clave:** Ganado de carne; Dietas ricas en cereales; Comportamiento ingestivo; Metabolitos plasmáticos.
1. Introduction

The efficiency in beef cattle production is considered a great challenge and has been a
target of innumerable research and discussions over the years, indicating the need to maximize
production through the development of the entire meat production chain. The finishing phase
in a feedlot of the animals, which was been studied in this work is one of the phases more
important on the production cycle. This is an onerous phase due to the high costs of a quality
feed, thus allowing the animals to express their full genetic potential. Thus, the use of new
alternatives to increase the productivity of the cattle herd has been studied more frequently,
being the class of growth promoters in the highlighted (Fugita et al., 2018; Monteschio et al.,
2017; Ornaghi et al., 2017; Souza et al., 2019).

In the last decades, antibiotics were commonly administered in the diet of animals with
the function of modulating bacterial flora, but their use is undergoing some restrictions in
European Union (OJEU, 2003) and the USA (FDA, 2015). Therefore, alternative products that
promote a satisfactory animals’ performance without compromising the quality of the final
product (meat) offered to beef consumers are being investigated (Cruz et al., 2014; Guerrero et
al., 2018; Monteschio et al., 2017; Rivaroli et al., 2016).

In this situation many studies are being carried out in this area, searching for a natural
substitute that meets such requirements. The use of plant extracts is an alternative to replace
antibiotics (Benchaar et al., 2008; Cruz et al., 2014; Valero et al., 2016), besides acting as
antimicrobials and antioxidants, benefitting the immune and digestive system of animals
(Jayasena & Jo, 2013; Ornaghi et al., 2017).

This includes the plant of *Baccharis dracunculifolia*, being a native plant from Brazil,
commonly known as “Alecrim do campo”. This extract is composed of aliphatic hydrocarbons,
cyclic hydrocarbons, terpenes (baccharin), isopropanol, flavonoids (isosakuranetin,
 aromadendrin-4’-methyl ether) and phenolic acid (artepelin C, caffeic acid, p-coumaric acid,
ferulic acid) (Campos et al., 2016; Kumazawa et al., 2003); however, having the artepelin C as
the principal compound (Veiga et al., 2017), besides presenting potential as antioxidants
(Oliveira et al., 2003), classifying themselves as biological, antimicrobial, antioxidant and anti-
inflammatory agents (Tiveron et al., 2016).

This study was carried out to evaluate the effects of the addition/inclusion of plant leaves
of *Baccharis dracunculifolia in nature* on animal performance, feed intake, ingestive behavior
activities, and blood parameters of steers finished in the feedlot with high-grain diets.
2. Materials and Methods

2.1. Ethics committee

This experiment was approved by the committee for ethics in the use of animals (CEUA) of the Universidade Estadual de Maringá, following protocol 3624120116.

2.2. Animals and experimental diet

Forty Nellore purebred steers with a mean initial body weight (BW) of 412.9 ± 22.0 kg were used in this study. Steers were distributed randomly in individual pens, with dimensions of 10 m² for each animal, partially covered and equipped with automatic drinkers and masonry feeders. The period of adaptation to the feedlot and concentrate diet was 14 days; afterwards, the experimental period was extended to 56 days until animals reached a mean final body weight of 499.9 ± 25.6 kg. During the experimental period, Nellore steers were weighed monthly to record weight gain and productivity variables. We used the quantitative method (Pereira et al., 2018), carried out by means of field research to assess the performance, feed intake, ingestive behavior, and blood parameters of Nellore steers finished in feedlot on high-grain diets.

Steers were randomly assigned to one of four studied diets with ten steers per diet group. The diets tested were CONT – basal diet; BAC05 – basal diet and inclusion of B. dracunculifolia leaves in natura (5 g/animal/day); BAC10 – basal diet and inclusion of B. dracunculifolia leaves in natura (10 g/animal/day); and BAC15 – basal diet and inclusion of B. dracunculifolia leaves in natura (15 g/animal/day). The plant included in the diet was made every 15 days, to calculate and adjust the dose by period depending on the intake of dry matter (DM)/d per animal. Preparation of diets was made with a pre-mix of plant in nature in the soybean meal and ground corn then led to the feed mixer together with other ingredients. The Leaves of B. dracunculifolia in nature had a powder texture and were obtained of a single property through the manual collection of the leaves of the plant, which were processed in a knife mill to be offered to the animals.

The basal diets, consisting of pre-dried Tifton 85 hay, corn grain, and the dry leaves of B. dracunculifolia in nature was mixed with soybean meal, ground corn, yeast, mineral salt, and top-dressed daily into the morning feeding of respective treatments pens (1.60 kg of mixture/steers daily). Soybean meal was also top-dressed into the morning feeding of CONT
pens (1.60 kg/steers daily), without the addition of the experimental ingredients. All diets were isonitrogenous, isoenergetic, and formulated to meet the requirements for a gain of 1.7 kg/d (NRC, 2000) with adequate concentrations of nutrients for the growth and finishing of animals (Table 1).

### Table 1. Ingredient composition of total mixed ration offered during the experiment.

| Ingredients, g/kg od DM | CONT<sup>a</sup> | BAC05<sup>b</sup> | BAC10<sup>c</sup> | BAC15<sup>d</sup> |
|------------------------|------------------|------------------|------------------|------------------|
| Pre-dried hay          | 150              | 150              | 150              | 150              |
| Corn grain             | 710              | 710              | 710              | 710              |
| Soybean meal           | 51.0             | 51.0             | 51.0             | 51.0             |
| Ground corn            | 85.0             | 85.0             | 85.0             | 85.0             |
| Yeast                  | 0.40             | 0.40             | 0.40             | 0.40             |
| Mineral salt<sup>e</sup> | 3.20             | 3.20             | 3.20             | 3.20             |
| Baccharis dracunculifolia | -                | 0.05             | 0.10             | 0.15             |

<sup>a</sup>CONT = basal diet; <sup>b</sup>BAC05 = basal diet and inclusion of B. dracunculifolia leaves in natura (5 g/animal/day); <sup>c</sup>BAC10 = basal diet and inclusion of B. dracunculifolia leaves in natura (10 g/animal/day); and <sup>d</sup>BAC15 = basal diet and inclusion of B. dracunculifolia leaves in natura (15 g/animal/day). <sup>e</sup>Mineral mix composition (kg): calcium, 50 g; magnesium, 57 g; sodium, 81 g; sulfur, 3.75 g; cobalt, 20 mg; copper, 500 mg; iodine, 25 mg; manganese, 1,500 mg; selenium, 10 mg; zinc, 2,000 mg; vitamin A, 400,000 UI; vitamin D3, 50,000 UI; vitamin E, 750 UI; ether extract, 168 g; urea, 200 g. Source: Authors.

2.3. Chemical analyses

The chemical compositions of ingredients and experimental diets were presented as g/kg of DM (Table 2).

### Table 2. Chemical composition of total mixed ration offered during the experiment.

| Item                      | DM<sup>1</sup> | Ash | CP<sup>2</sup> | EE<sup>3</sup> | NDF<sup>4</sup> | ADF<sup>5</sup> | NNE<sup>6</sup> | TDN<sup>7</sup> | DE<sup>8</sup> |
|--------------------------|----------------|-----|---------------|---------------|----------------|----------------|----------------|----------------|----------------|
| Ingredients (g/kg of DM)  |                |     |               |               |                |                |                |                |                |
| Pre-dried hay            | 337            | 73.1| 155           | 18.1          | 828            | 358            | 461            | 581            | 25.6           |
| Corn grain               | 853            | 16.4| 96.1          | 47.1          | 175            | 45.8           | 845            | 635            | 2.80           |
| Ground corn              | 875            | 15.7| 90.7          | 39.8          | 136            | 43.6           | 838            | 857            | 37.8           |
| Soybean meal             | 850            | 67.0| 489           | 19.0          | 159            | 87.8           | 450            | 822            | 36.2           |
| Yeast                    | 920            | 46.1| 331           | 21.0          | 26.0           | 9.22           | -              | -              | -              |
| Mineral salt             | 986            | 945 | -             | -             | -              | -              | -              | -              | -              |
| Baccharis dracunculifolia| 539            | 61.3| 130           | 22.3          | 533            | 356            | 602            | 655            | 28.9           |
| Diet                     | 776            | 32.1| 138           | 39.8          | 269            | 95.9           | 750            | 651            | 10.8           |

<sup>1</sup>DM, dry matter; <sup>2</sup>CP, crude protein; <sup>3</sup>EE, ether extract; <sup>4</sup>NDF, neutral detergent fiber; <sup>5</sup>ADF, acid detergent fiber; <sup>6</sup>NNE, non nitrogen extractive; <sup>7</sup>TDN, total digestible nutrients; <sup>8</sup>DE, digestible energy. Source: Author's.
DM was estimated after oven drying at 65° C for 24 h and milling through a 1-mm screen following method ID 934.01 (AOAC, 2005). Ash content was measured by combustion at 550° C for 16 h according to method ID 942.05 (AOAC, 2005). Nitrogen concentration was determined by the Kjeldahl method (ID 988.05) (AOAC, 2005). Following the determination of nitrogen concentration, crude protein was calculated by multiplying the nitrogen content by a factor of 6.25. Ether extract content was determined by method ID 920.39 (AOAC, 2005). The neutral detergent fiber (NDF) content was measured according to the recommendations of Mertens (2002) using α-amylase and was expressed inclusive of residual ash. The acid detergent fiber was measured by using method ID 973.18 (AOAC, 2005) and was expressed inclusive of residual ash. The non-nitrogen extract was obtained by equation according to AOAC (2005). The digestible energy was calculated according to the recommended equations (NRC, 2000). Total digestible nutrients (TDN) content of diets was obtained by the methodology describe by Kearl (1982), using the equation for pre-dried:

\[
\text{Hay} = -17.2649 + 1.2120 \times (\% \text{ CP}) + 0.8352 \times (\% \text{ ENN}) + 2.4637 \times (\% \text{ EE}) + 0.4475 \times (\% \text{ CF}).
\]

\[
\text{Energetic foods} = 40.2625 + 0.1969 \times (\% \text{ CP}) + 0.4228 \times (\% \text{ ENN}) + 1.1903 \times (\% \text{ EE}) + 0.1379 \times (\% \text{ CF}).
\]

\[
\text{Protein foods} = 40.3227 + 0.5398 \times (\% \text{ CP}) + 0.4448 \times (\% \text{ ENN}) + 1.4218 \times (\% \text{ EE}) - 0.7007 \times (\% \text{ CF}).
\]

**2.4. Animal performance**

Diets were offered at 08:00 and 16:00 h every day. Feed intake was estimated as the difference between the feed supplied and refusals in the trough. To determine growth performance, animals were weighed at the beginning of the experiment and then every month (after fasting for 16 h), throughout the experiment. The average daily gain was calculated as the total BW gain divided by the length of the experimental period (56 days). Feed efficiency was calculated as the ratio between average daily gain and DM intake.

When the Nellore steers reached a mean final body weight of 499.9 ± 25.6 kg, they were slaughtered in a commercial slaughterhouse 153 km from the Iguatemi Experimental Farm. Animal transport was carried out in the late afternoon to minimize stress. Upon arrival at the slaughterhouse, animals were kept in resting pens and were subsequently stunned using a
penetrating captive bolt pistol as per Brazilian federal inspection regulations according to the Brazilian RIISPOA – Regulation of Industrial and Sanitary Inspection of Animal Products.

2.5. Ingestive behavior activities

Data relative to the ingestive behavior of steers were obtained between the 7th and 8th weeks of a feedlot. The record of the quantitative data on the basic behavioral patterns was according to Silva et al. (2005), through visual observation of the animals every 5 min during 1 minute performed by a trained team during 12 uninterrupted hours. A spreadsheet was used to organize the records collected chronologically regarding the duration of feeding and drinking by the number of action observation times. For ruminating and idle periods, the total time spent on each activity was determined by the sum of the repetitions.

2.6. Blood analyses

Blood samples were evaluated every 18 days for a total of three individual collections per animal in the vacutioner® tube and maintained at a temperature of 25°C with the mean for facilitating the coagulation, and then were performed the serum separation by centrifugation (Centrifuge, Rotina 420-R, Tuttlingen, Germany), being used a speed of 3000 rpm/15 min. The evaluation of parameters like urea and creatine was performed according to Vasconcelos et al. (2007). The activities of muscle injury indicative enzymes aspartate aminotransferase (AST) and creatine kinase (CK) were measured in a spectrophotometer (Spectrophotometer UV-Vis-Evolution 200, Massachusetts, United State of America) using commercial enzymatic dosage kits (Bioclin, Belo Horizonte, Brazil) according to the manufacturer's instructions. The gamma-glutamyl transferase (GGT) was performed using Roche assay reagents in the Roche 900 series automated clinical chemical analyzer (Roche Diagnostics, Indiana, United State of America).

2.7. Statistical Analyses

The experimental design was completely randomized with four treatments and ten replications. The results were statistically interpreted using regression equations performed in SAS (2004) (PROC REG):

\[ Y_{ijk} = \beta_0 + \beta_1 X_i + \beta_2 X_i^2 + a_{ijk} + e_{ijk} \]
where: \( Y_{ijk}, \beta_0, X_{ijk}, \alpha_{ijk}, \) and \( \varepsilon_{ijk} \) are Dependent variables (plant levels); Regression coefficient; Independent variables; Regression deviations; and Residual error, respectively.

3. Results

The inclusion of up to 15 g/animal/day of the leaves of *Baccharis dracunculifolia in nature* in the steers’ diets finished in the feedlot did not affect \((P \geq 0.47)\) final body weight, average daily gain, dry matter intake, and feed efficiency (Table 3).

Table 3. Performance parameters of steers supplemented or not with plant *in nature* during the feedlot-finishing period.

| Parameters                  | Experimental diets | SEM[^5] | \( P\)-value |
|-----------------------------|--------------------|---------|--------------|
|                             | CONT[^1] | BAC05[^2] | BAC10[^3] | BAC15[^4] | L    | Q    |
| Initial body weight, kg     | 415       | 415      | 413       | 409       | 3.89  | 0.61 | 0.85 |
| Final body weight, kg       | 499       | 499      | 506       | 496       | 4.56  | 0.97 | 0.86 |
| Average daily gain, kg/d    | 1.50      | 1.50     | 1.66      | 1.55      | 0.05  | 0.53 | 0.72 |
| Dry matter intake, kg/d     | 9.13      | 9.29     | 9.16      | 9.09      | 0.13  | 0.84 | 0.89 |
| Feed efficiency[^6]         | 0.17      | 0.16     | 0.18      | 0.17      | 0.01  | 0.47 | 0.75 |

[^1]CONT = basal diet; 2BAC05 = basal diet and inclusion of *B. dracunculifolia leaves in natura* (5 g/animal/day); 3BAC10 = basal diet and inclusion of *B. dracunculifolia leaves in natura* (10 g/animal/day); and 4BAC15 = basal diet and inclusion of *B. dracunculifolia leaves in natura* (15 g/animal/day); 5SEM - standard error of the mean; 6kg average daily gain/kg dry matter feed intake. Source: Authors.

No treatment effects were detected \((P \geq 0.23)\) for ingestive behavior activities during the 12 uninterrupted hours for activities drinking, feeding, rumination, idleness (Table 4).

Table 4. Ingestive behavior activities parameters of steers supplemented or not with plant *in nature* during the feedlot finishing period.

| Activities                | Experimental diets | SEM[^5] | \( P\)-value |
|---------------------------|--------------------|---------|--------------|
|                            | CONT[^1] | BAC05[^2] | BAC10[^3] | BAC15[^4] | L    | Q    |
| Drinking, Nu. visits      | 3        | 3        | 4        | 3         | 0.36  | 0.85 | 0.95 |
| Feeding, Nu. visits       | 21       | 22       | 22       | 24        | 1.02  | 0.23 | 0.48 |
| Rumination time, hours    | 100      | 109      | 70.0     | 112       | 8.02  | 0.97 | 0.61 |
| Idleness time, hours      | 500      | 486      | 520      | 471       | 9.27  | 0.51 | 0.52 |

[^1]CONT = basal diet; 2BAC05 = basal diet and inclusion of *B. dracunculifolia leaves in natura* (5 g/animal/day); 3BAC10 = basal diet and inclusion of *B. dracunculifolia leaves in natura* (10 g/animal/day); and 4BAC15 = basal diet and inclusion of *B. dracunculifolia leaves in natura* (15 g/animal/day); 5SEM - standard error of the mean. Source: Authors.
No treatment effects were detected ($P \geq 0.12$; Table 5) for plasma concentrations of urea, creatine, aspartate aminotransferase, gamma-glutamyl transferase, and creatine kinase.

### Table 5. Concentrations of plasma urea (mg/dl), creatine (mg/dl), aspartate aminotransferase (U/l), gamma-glutamyl transferase (U/l), creatine kinase (U/l) in steers supplemented or not with plant in nature during the feedlot finishing period.

| Parameters                        | Experimental diets | SEM$^5$ | P-value |
|-----------------------------------|--------------------|---------|---------|
|                                   | CONT$^1$ | BAC05$^2$ | BAC10$^3$ | BAC15$^4$ | L  | Q  |
| Urea                              | 38.5     | 40.0     | 37.0     | 38.0     | 1.26 | 0.47 | 0.62 |
| Creatine                          | 2.79     | 2.99     | 2.77     | 3.29     | 0.09 | 0.13 | 0.23 |
| Aspartate aminotransferase        | 186      | 197      | 174      | 181      | 6.11 | 0.49 | 0.79 |
| Gamma glutamyl transferase        | 44.5     | 46.2     | 43.7     | 47.8     | 1.94 | 0.12 | 0.22 |
| Creatine kinase                   | 334      | 384      | 429      | 430      | 24.8 | 0.14 | 0.31 |

$^1$CONT = basal diet; $^2$BAC05 = basal diet and inclusion of *B. dracunculifolia* leaves in natura (5 g/animal/day); $^3$BAC10 = basal diet and inclusion of *B. dracunculifolia* leaves in natura (10 g/animal/day); and $^4$BAC15 = basal diet and inclusion of *B. dracunculifolia* leaves in natura (15 g/animal/day); $^5$SEM - standard error of the mean. Source: Authors.

### 4. Discussion

The finished period, especially feedlot is a term in which beef cattle need a contribution against diseases, metabolic disorders, and ruminal digestion as fermentative modulators (Russell & Strobel, 1989; Souza et al., 2018). The *B. dracunculifolia* has great importance in Brazilian botany (Bankova et al., 1999; Campos et al., 2016; Silva Filho et al., 2004), because of their antibacterial effect (Silva Filho et al., 2008; Veiga et al., 2017) this same effect is found both in the plant in nature and in the propolis and/or as it can be called "green propolis" that is produced by bees that use the nectar of the plant flowers.

The studies reported by other authors (Valero et al., 2014; Zawadzki et al., 2011) prove that the use of propolis in beef cattle diets can improve the average daily gain. This improvement is due to the efficiency of the use of nutrients in the rumen, as a decrease in the losses coming from the methane gas (Callaway et al., 2003). However, the results from the current experiment did not report an improvement on average daily gain variables with the addition/inclusion of the leaves of *B. dracunculifolia*.

According to laboratory works performed by Búfalo et al. (2009); Massignani et al. (2009); Parreira et al. (2010) and Guimarães et al. (2012) using *B. dracunculifolia in nature* as substrate proves *in vitro* the antiviral, antiprotozoal, antioxidant, and antibacterial power; in particular the antibacterial effect is related to the greater sensitivity of the gram-positive bacteria.
to the action mechanisms of this extract, corroborating with the results found by Zawadzki et al. (2011) and (Valero et al. (2014) on natural propolis.

Even without the differentiation between the treatments from animals that received or not the supplementation with the plant extracts, the average daily gain can be considered satisfactory for feedlot animals fed a high grain diet on the Nellore breed (Françozo et al., 2013; Maggioni et al., 2010). The final body weight, dry matter intake, and feed efficiency had similar results between treatment animals throughout the experimental period (Table 3). The plant in nature presents high levels of flavonoids and phenol (Kumazawa et al., 2003; Paula et al., 2017), consequently, these concentrations in steers’ diet negatively influenced ruminal dynamics, justifying the lack of effect detection for feed efficiency.

Ingestive behavior activities (feeding, drinking, ruminating, and idle; Table 4) were similar among the treatments that received the vegetal extract or not, this resemblance is possibly explained due to the similarity between the feedlot pens, as well as the basal diet offered to the animals. Corroborating with these results other works carried out under similar conditions and with the inclusion of natural additives (essential oils) as those from our research group (Ornaghi et al., 2017) who did not detect either effect for ingestive behavior on young bulls receiving a high concentrated diet.

Results for feeding and ruminating are in according with (Eiras et al., 2014; Missio et al., 2010; Ornaghi et al., 2017) who also evaluated ingestive behavior on beef cattle feedlot supplemented with a high concentrated diet. The low levels for these activities are understood due to the greater energetic support that this type of diet provides; thus, the animals reach their nutritional requirements and cease their consumption. According to Van Soest (1994), a diet with a higher percentage of forage increase the time used for rumination, that is, a high concentrate diet due to the size of its particles may have reduced the rumination capacity of the present study steers. Another factor that may have compromised the rumination rate is the high levels of phenolic substances found in B. dracunculifolia (Park et al., 2002; Tiveron et al., 2016) which adversely affected the use of feed by ruminal bacteria.

The observation of the beef cattle behavior from feedlot presents great importance, to guarantee the maximum production of the animals without taking unnecessary management, avoiding more intense periods used by the animals in the use of feed intake. In addition, the feed offered to animals at shorter intervals of time is aimed at improving the absorption of the nutrient (Itavo et al., 2011).

Stresses being by transport, dehydration, or nutrient-poor diets influence metabolism, through changes in plasma concentrations of urea, total protein, and creatine kinase (Buckham
corroborating with this affirmation Berschauer et al. (1983) report that with increasing feed intake there is a decrease in blood urea concentrations. In the present study, the results for urea, creatine, and creatine kinase were above what is classified as a reference for cattle (Table 5). Therefore, these results indicate that the steers did not suffer any type of metabolic alteration during the experimental period, but in the period before the experiment.

The plasma blood concentration of steers fed *B. dracunculifolia* for aspartate aminotransferase and gamma-glutamyl transferase were higher according to the results found by Gandra et al. (2012). The possible explanation for this small difference is the forage: concentrate ratio of the diet, since high concentrate diets can induce liver injury (Mori et al., 2007). Therefore, with the inclusion of the plant extract, no clinical alterations were observed due to infectious, neurological, or metabolic diseases, which could negatively influence the performance and health of the steers.

5. Conclusion

The inclusion up to 15 g/animal/day of dry leaves of *Baccharis dracunculifolia in nature* does not affect animal performance, ingestive animal behavior, and blood plasma parameters on finished steers in a feedlot. The results from this study suggest that the use of this plant in the diet of steers does not cause any feed injury.

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References

AOAC. (2005). Association Official Analytical Chemist. In A. O. A. Chemist (Ed.), *Official Methods of Analysis* (18a ed.). Gaitherburg.

Bankova, V., Christov, R., Popov, S., Marcucci, M. C., Tsvetkova, I., & Kujumgiev, A. (1999).
Antibacterial activity of essential oils from Brazilian propolis. *Fitoterapia*, 70(2), 190–193. https://doi.org/10.1016/S0367-326X(98)00045-8.

Benchaar, C., Calsamiglia, S., Chaves, A. V., Fraser, G. R., Colombatto, D., McAllister, T. A., & Beauchemin, K. A. (2008). A review of plant-derived essential oils in ruminant nutrition and production. *Animal Feed Science and Technology*, 145(1–4), 209–228. https://doi.org/10.1016/j.anifeedsci.2007.04.014

Berschauer, F., Close, W. H., & Stephens, D. B. (1983). The influence of protein: energy value of the ration and level of feed intake on the energy and nitrogen metabolism of the growing pig: 2. N metabolism at two environmental temperatures. *British Journal of Nutrition*, 49(2), 271–283.

Buckham, S., Xiao L., K. R., & Tempelman, R. J. (2008). Transportation stress alters the circulating steroid environment and neutrophil gene expression in beef bulls. *Veterinary Immunology and Immunopathology*, 121(3), 300–320. https://doi.org/10.1016/j.vetimm.2007.10.010.

Búfalo, M. C., Figueiredo, A. S., Sousa, J. P. B., Candeias, J. M. G., Bastos, J. K., & Sforcin, J. M. (2009). Anti-poliovirus activity of *Baccharis dracunculifolia* and propolis by cell viability determination and real-time PCR. *Journal of Applied Microbiology*, 107(5), 1669–1680. https://doi.org/10.1111/j.1365-2672.2009.04354.x.

Callaway, T. R., Edrington, T. S., Rychlik, J. L., Genovese, K. J., Poole, T. L., Jung, Y. S., Bischoff, K. M., Anderson, R. C., & Nisbet, D. J. (2003). Ionophores: their use as ruminant growth promotants and impact on food safety. *Current Issues in Intestinal Microbiology*, 4(2), 43–51.

Campos, R., Bressan, J., Cristina, V., Jasinski, G., Zuccolotto, T., Eduardo, L., & Cerqueira, L. B. (2016). *Baccharis (Asteraceae): Chemical Constituents and Biological Activities*. *Chemistry and Biodiversity*, 13, 1–17. https://doi.org/10.1002/cbdv.201500363

Cruz, O. T. B., Valero, M. V., Zawadzki, F., Rivaroli, D. C., Prado, R. M., Lima, B. S., & Prado, I. N. (2014). Effect of Glycerine and Essential Oils (*Anacardium Occidentale* and *Ricinus*
Communis) on Animal Performance, Feed Efficiency and Carcass Characteristics of Crossbred Bulls Finished in a Feedlot System. *Italian Journal of Animal Science*, 13(4), 3492. https://doi.org/10.4081/ijas.2014.3492f

Earley, B., & O’Riordan, E. G. (2006). Effects of transporting bulls at different space allowances on physiological, haematological and immunological responses to a 12-h journey by road. *Irish Journal of Agricultural and Food Research*, 39–50.

Eiras, C. E., Marques, J. A., Prado, R. M., Valero, M. V., Bonafé, E. G., Zawadzki, F., Perotto, D., & Prado, I. N. (2014). Glycerin levels in the diets of crossbred bulls finished in feedlot: Carcass characteristics and meat quality. *Meat Science*, 96(2), 930–936. https://doi.org/10.1016/j.meatsci.2013.10.002.

FDA. (2015). *Food and Drug Administration of the US, Substances used as GRAS in food*. 21, CFR 184.

Françozo, M. C., Prado, I. N., Cecato, U., Valero, M. V., Zawadzki, F., Ribeiro, O. L., Prado, R. M., & Visentainer, J. V. (2013). Growth performance, carcass characteristics and meat quality of finishing bulls fed crude glycerin- supplemented diets. *Brazilian Archives of Biology and Technology*, 56(2). https://doi.org/10.1590/S1516-89132013000200019

Fugita, C. A., Prado, R. M., Valero, M. V., Bonafé, E. G., Carvalho, C. B., Guerrero, A., Sañundo, C., & Prado, I. N. (2018). Effect of the inclusion of natural additives on animal performance and meat quality of crossbred bulls (Angus vs. Nellore) finished in feedlot. *Animal Production Science*, 58(11), 2076–2083. https://doi.org/10.1071/AN16242.

Gandra, J. R., Gil, P. C. N., Cônsolo, N. R. B., Gandra, E. R. S., & Gobesso, A. A. O. (2012). Addition of increasing doses of ricinoleic acid from castor oil (*Ricinus communis L.*) in diets of Nellore steers in feedlots. *Journal of Animal and Feed Sciences*, 21, 566–576.

Guerrero, A., Rivaroli, D. C., Sañudo, C., Campo, M. M., Valero, M. V., Jorge, A. M., & Prado, I. N. (2018). Consumer acceptability of beef from two sexes supplemented with essential oil mix. *Animal Production Science*, 58(9), 1700–1707. https://doi.org/10.1071/AN15306
Guimarães, N. S. S., Mello, J. C., Paiva, J. S., Bueno, P. C. P., Berretta, A. A., Torquato, R. J., Nantes, I. L., & Rodrigues, T. (2012). *Baccharis dracunculifolia*, the main source of green propolis, exhibits potent antioxidant activity and prevents oxidative mitochondrial damage. *Food and Chemical Toxicology, 50*(3–4), 1091–1097. https://doi.org/10.1016/j.fct.2011.11.014

Ítavo, C. C. B. F., Morais, M. G., Costa, C., Ítavo, L. C. V., Franco, G. L., Silva, J. A., & Reis, F. A. (2011). Addition of propolis or monensin in the diet: Behavior and productivity of lambs in feedlot. *Animal Feed Science and Technology, 165*(3–4), 161–166. https://doi.org/10.1016/j.anifeedsci.2011.02.020

Jayasena, D. D., & Jo, C. (2013). Essential oils as potential antimicrobial agents in meat and meat products: A review. *Trends in Food Science & Technology, 34*(2), 96–108. https://doi.org/10.1016/j.tifs.2013.09.002.

Kearl, L. C. (1982). *Nutrient requirements of ruminants in developing countries* (1st ed.). International Feedstuffs Institute, Utah Agricultural Experiment Station, Utah State University. Retrieved from http://books.google.com.br/books?id=cf6uAAAACAAJ

Kumazawa, S., Yoneda, M., Shibata, I., Kanaeda, J., Hamasaka, T., & Nakayama, T. (2003). Direct evidence for the plant origin of Brazilian propolis by the observation of honeybee behavior and phytochemical analysis. *Chemical and Pharmaceutical Bulletin, 51*(6), 740–742.

Maggioni, D., Marques, J. A., Rotta, P. P., Perotto, D., Ducatti, T., Visentainer, J. V., & Prado, I. N. (2010). Animal performance and meat quality of crossbred young bulls. *Livestock Science, 127*(2–3). https://doi.org/10.1016/j.livsci.2009.09.006.

Massignani, J. J., Lemos, M., Maistro, E. L., Schaphauser, H. P., Jorge, R. F., Sousa, J. P. B., Bastos, J. K., & Andrade, S. F. (2009). Antiulcerogenic activity of the essential oil of *Baccharis dracunculifolia* on different experimental models in rats. *Phytotherapy Research, 23*(10), 1355–1360.

Mertens, D. R. (2002). Gravimetric determination of amylase-treated neutral detergent fiber in feeds with refluxing in beakers or crucibles: collaborative study. *Journal of AOAC International, 85*(6), 1217–1240. Retrieved from http://www.ncbi.nlm.nih.gov/pu
Missio, R. L., Brondani, I. L., Alves Filho, D. C., Silveira, M. F., Freitas, L. S., & Restle, J. (2010). Comportamento ingestivo de tourinhos terminados em confinamento, alimentados com diferentes níveis de concentrado na dieta. Revista Brasileira de Zootecnia, 39(7), 1571–1578. https://doi.org/10.1590/S1516-35982010000700025.

Monteschio, J. O., Souza, K. A., Vital, A. C. P., Guerrero, A., Valero, M. V., Kempinski, E. M. B. C., Barcelos, V. C., Nascimento, K. F., & Prado, I. N. (2017). Clove and rosemary essential oils and encapsuled active principles (eugenol, thymol and vanillin blend) on meat quality of feedlot-finished heifers. Meat Science, 130, 50–57. https://doi.org/10.1016/j.meatsci.2017.04.002.

Mori, A., Urabe, S., Asada, M., Tanaka, Y., Tazaki, H., Yamamoto, I., Kimura, N., Ozawa, T., Morris, S. T., Hickson, R., Kenyon, P. R., Blair, H., Choi, C. B., & Arai, T. (2007). Comparison of plasma metabolite concentrations and enzyme activities in beef cattle raised by different feeding systems in Korea, Japan and New Zealand. Journal of Veterinary Medicine Series A, 54(7), 342–345. https://doi.org/10.1111/j.1439-0442.2007.00964.x

NRC. (2000). Nutrient Requirements of Beef Cattle. In Nutrient Requirements of Beef Cattle. https://doi.org/10.17226/9791

OJEU. (2003). Regulation (EC) No. 1831/2003 of European Parliament and the Council of 22 September 2003 on additives for use in animal nutrition. In Official Journal of European Union. 10(18).

Oliveira, S. Q., Dal-Pizzol, F., Gosmann, G., Guillaume, D., Moreira, J. C. F., & Schenkel, E. P. (2003). Antioxidant activity of Baccharis articulata extracts: isolation of a new compound with antioxidant activity. Free Radical Research, 37(5), 555–559.

Ornaghi, M. G., Passetti, R. A. C. C., Torrecilhas, J. A., Mottin, C., Vital, A. C. P., Guerrero, A., Sañudo, C., del Mar Campo, M., & Prado, I. N. (2017). Essential oils in the diet of young bulls: Effect on animal performance, digestibility, temperament, feeding behaviour and carcass characteristics. Animal Feed Science and Technology, 234, 274–283. https://doi.org/10.1016/j.anifeed
Park, Y. K., Alencar, S. M., & Aguilar, C. L. (2002). Botanical origin and chemical composition of Brazilian propolis. *Journal of Agricultural and Food Chemistry, 50*(9), 2502–2506. https://doi.org/10.1021/jf011432b.

Parreira, N. A., Magalhães, L. G., Morais, D. R., Caixeta, S. C., Sousa, J. P. B., Bastos, J. K., Cunha, W. R., Silva, M. L. A., Nanayakkara, N. P. D., & Rodrigues, V. (2010). Antiprotozoal, schistosomicidal, and antimicrobial activities of the essential oil from the leaves of Baccharis dracunculifolia. *Chemistry & Biodiversity, 7*(4), 993–1001.

Paula, J. T., Sousa, I. M. O., Foglio, M. A., & Cabral, F. A. (2017). Selective fractionation of supercritical extracts from leaves of *Baccharis dracunculifolia*. *The Journal of Supercritical Fluids, 127*, 62–70. https://doi.org/10.1016/j.supflu.2017.03.032

Pereira, A. S., Shitsuka, Dorlivete Moreira Parreira, F. J., & Shitsuka, R. (2018). *Methodology of scientific research*. [e-Book]. Santa Maria City. UAB/NTE/UFSM Editors. Retrieved from https://repositorio.ufsm.br/bitstream/handle/1/15824/Lic_Computacao_Metodologia-Pesquisa-Cientifica.pdf?sequence=1.

Rivaroli, D. C., Guerrero, A., Valero, M. V., Zawadzki, F., Eiras, C. E., Campo, M. D. M., Sañudo, C., Jorge, A. M., & Prado, I. N. (2016). Effect of essential oils on meat and fat qualities of crossbred young bulls finished in feedlots. *Meat Science, 121*, 278–284. https://doi.org/10.1016/j.meatsci.2016.06.017

Russell, J. B., & Strobel, H. J. (1989). Effect of ionophores on ruminal fermentation. *Applied and Environmental Microbiology, 55*(1), 1–6. https://doi.org/10.1128/aem.55.1.1-6.1989.

Silva Filho, A A, Bueno, P. C. P., Gregório, L. E., Silva, M. L. A., Albuquerque, S., & Bastos, J. K. (2004). In-vitro trypanocidal activity evaluation of crude extract and isolated compounds from *Baccharis dracunculifolia DC* (Asteraceae). *Journal of Pharmacy and Pharmacology, 56*(9), 1195–1199. https://doi.org/10.1211/0022357044067.

Silva Filho, Ademar A, Sousa, J. P. B., Soares, S., Furtado, N. A. J. C., Silva, M. L. A., Cunha,
W. R., Gregório, L. E., Nanayakkara, N. P. D., & Bastos, J. K. (2008). Antimicrobial activity of the extract and isolated compounds from *Baccharis dracunculifolia* DC (Asteraceae). *Zeitschrift Für Naturforschung C, 63*(1–2), 40–46.

Silva, R. R., Silva, F. F., Carvalho, G. G. P., Franco, I. L., Veloso, C. M., Chaves, M. A., Bonomo, P., Prado, I. N., & Almeida, V. S. (2005). Comportamento ingestivo de novilhas mestiças de Holandês X Zebu confinadas. *Archivos de Zootecnia, 54*(205), 75–85.

Souza, K. A., Cooke, R. E., Aschubach, K. M., Brandão, A. P., Schumher, T. F., Prado, I. N., Marques, R. S., & Bohnert, D. W. (2018). Performance, health and physiological responses of newly-weaned feedlot cattle supplemented with feed-grade antibiotics or alternative feed ingredients. *Animal, 12*(12), 2521–2528. https://doi.org/10.1017/S1751731118000551.

Souza, K. A., Monteschio, J. O., Mottin, C., Ramos, T. R., Pinto, L. A. M., Eiras, C. E., Guerrero, A., & Prado, I. N. (2019). Effects of diet supplementation with clove and rosemary essential oils and protected oils (eugenol, thymol and vanillin) on animal performance, carcass characteristics, digestibility, and behavior activities for Nellore heifers finished in feedlot. *Livestock Science, 220*, 190–195. https://doi.org/http://dx.doi.org/10.1016/j.livsci.2018.12.026.

Tarrant, P. V., Kenny, F. J., Harrington, D., & Murphy, M. (1992). Long distance transportation of steers to slaughter: effect of stocking density on physiology, behaviour and carcass quality. *Livestock Production Science, 30*(3), 223–238. https://doi.org/10.1016/S0301-6226(06)80012-6.

Tiveron, A. P., Rosalen, P. L., Franchin, M., Lacerda, R. C. C., Bueno-Silva, B., Benso, B., Denny, C., Ikegaki, M., & de Alencar, S. M. (2016). Chemical characterization and antioxidant, antimicrobial, and anti-inflammatory activities of south Brazilian organic propolis. *PloS One, 11*(11), e0165588.

Valero, M. V., Torrecilhas, J. A., Zawadzki, F., Bonafé, E. G., Madrona, G. S., Prado, R. M., Passetti, R. A., Rivaroli, D. C., Visentainer, J. V., & Prado, I. N. (2014). Propolis or cashew and castor oils effects on composition of Longissimus muscle of crossbred bulls finished in feedlot. *Chilean Journal of Agricultural Research, 74*(4), 445–451. https://doi.org/10.4067/S0718-58392014000400011
Valero, M. V, Farias, M. S., Zawadzki, F., Prado, R. M., Fugita, C. A., Rivaroli, D. C., Ornaghi, M., & Prado, I. N. (2016). Feeding propolis or functional oils (cashew and castor oils) to bulls: performance, digestibility and blood cells counts. *Revista Colombiana de Ciencias Pecuarias*, 29, 33–42. https://doi.org/10.17533/udea.rccp.v29n1a04.

Van Soest, P. J. (1994). *Nutritional ecology of the ruminant* (Vol. 1, Issue 2). Cornell University Press.

Vasconcelos, S. M. L., Goulart, M. O. F., Moura, J. B. F., Manfredini, V., Benfato, M. da S., & Kubota, L. T. (2007). Espécies reativas de oxigênio e de nitrogênio, antioxidantes e marcadores de dano oxidativo em sangue humano: principais métodos analíticos para sua determinação. *Química Nova*, 30(5), 1323–1338.

Veiga, R. S., Mendonça, S., Mendes, P. B., Paulino, N., Mimica, M. J., Lagareiro Netto, A. A., Lira, I. S., López, B. G. C., Negrão, V., & Marcucci, M. C. (2017). Artepilin C and phenolic compounds responsible for antimicrobial and antioxidant activity of green propolis and *Baccharis dracunculifolia* DC. *Journal of Applied Microbiology*, 122(4). https://doi.org/10.1111/jam.13400

Zawadzki, F., Prado, I. N., Marques, J. A., Zeoula, L. M., Rotta, P. P., Sestari, B. B., Valero, M. V., & Rivaroli, D. C. (2011). Sodium monensin or propolis extract in the diets of feedlot-finished bulls: Effects on animal performance and carcass characteristics. *Journal of Animal and Feed Sciences*, 20(1), 16–25. https://doi.org/10.22358/jafs/66153/2011

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