A meta-analysis of the effects of dietary supplementation in tropical forage-fed cattle

Efeito da suplementação de bovinos de corte em pastagem tropical: abordagem meta-analítica

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Highlights:
Tropical pastures sometimes do not meet the requirements of cattle, regardless of supply.
Concentrated grazing supplementation makes the production system more efficient.
Rearing cattle are more dependent on protein supplements.

Abstract

The objective of this study was to, through a meta-analysis of published data, evaluate the effects of dietary supplementation on the performance of beef cattle grazed on Brachiaria pastures during the rearing and finishing phases of growth. Data from 15 Brazilian studies were analyzed, totaling 462 animals given different types and levels of supplementation. Animals were divided into two categories: 319 in the rearing phase, and 143 in the finishing phase. The reviewed studies evaluated the effects of protein, energy, and protein/energy supplementation on animal performance parameters. Daily weight gain and final live weight were analyzed using forest plots. Daily weight gain during the rearing phase was similar across all supplement types used. Animals given supplementation gained an average of 119 g more per day compared to those who received no supplementation. Specifically, protein supplementation resulted in an increase of 28.22 kg. Animals given supplementation of any kind, represented by the subgroups shown in the plots, gained an average of 24.47 kg more compared to the control group.

Key words: Brachiaria. Forest plot. Weight gain. Final live weight.

Resumo

O objetivo desse estudo foi avaliar por meio metanalítico os efeitos da suplementação no desempenho durante as fases de recría e terminação de bovinos de corte em pastagem de Brachiaria. Foram analisados dados combinados de 15 estudos nacionais, com um número total de 462 bovinos, submetidos à pastejo

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Introduction

Beef production in Brazil is significantly important in the world market due to the country’s natural resources, which support herd-development through forage, thus favoring increased production. In Brazil, forage grasses of the expressive genus *Brachiaria* are common. Depending on soil and climate conditions, the most common species include *Brachiaria decumbens*, *Brachiaria brizantha*, and *Brachiaria humidicola*. Together, these three species populate approximately 85% of the pastures in central Brazil (Empresa Brasileira de Pesquisa Agropecuária - Centro Nacional de Pesquisa em Gado de Corte [EMBRAPA-CNPGC], 2019). However, seasonal changes (predominantly during the dry season), decrease the nutritional value of these grasses due to degradation of the pastures; thus, resulting in low zootechnical performance (Moraes et al., 2012).

Considering the behavior of forage animals, it is important for the rural producer to stipulate objectives in the development process of the animal. Even during periods of maximum forage production, the nutritional requirements of the cattle may not be met, especially for growing animals. Nutritional deficiency results in a reduction in the rate and maximum capacity of weight gain, subsequently leading to higher expenses during the finishing phase. Consequently, the use of concentrated supplements in either season could correct specific nutrient deficiencies. Supplements are typically given at low levels to increase nutrient-availability for ruminal bacteria, improving use of the structural carbohydrates obtained from the pasture; thus, resulting in better animal performance. Therefore, in each situation it is necessary to analyze which type of supplement is appropriate to improve production rates.

We conducted a meta-analysis to evaluate the effects of dietary supplementation on the performance of cattle grazed in *Brachiaria* pastures during the rearing and finishing phases.

Materials and Methods

Data from 15 Brazilian studies were analyzed, totaling 462 animals grazed on tropical forage with different types and levels of supplementation. Animals were divided into two categories: 319 in the rearing phase, and 143 in the finishing phase (Table 1). The reviewed studies evaluated the effect of protein, energy, and protein/energy supplementation on parameters of animal performance. Literature published from 2004-2015 was found through the Scientific Electronic Library Online (http://www.scielo.br) or CAPES periodical portal (http://www.periodicos.capes.gov.br), using keywords: beef cattle OR supplementation OR pasture AND weight gain OR animal performance. Included studies must have had a control group without supplementation, used forage of the genus *Brachiaria*, took place in the tropical region of Brazil, and analyzed the daily weight gain and final body weight.
Animal performance parameters included the initial live weight (ILW), final live weight (FLW), and daily weight gain (DWG) for each phase. Data from the rearing and finishing phases varied greatly in ILW due to different body structure and development. Therefore, the mean live weight was 248.6 kg and 367.2 kg for the phases of rearing and finishing, respectively. Importantly, while all studies used *Brachiaria* forage, they were conducted during different times of the year, therefore, the performance of the animals was evaluated in the dry and wet seasons, with a mean forage mass of 6.56 ton ha$^{-1}$.

Table 1
Details and information on the studies included in the metanalysis

<table>
<thead>
<tr>
<th>Studies</th>
<th>Published</th>
<th>n</th>
<th>Forage</th>
<th>Categories</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reis et al. (2012)</td>
<td>50</td>
<td>Capim Marandu</td>
<td>Rearing</td>
<td>Prot./energ.</td>
</tr>
<tr>
<td>2</td>
<td>Porto et al. (2011)</td>
<td>30</td>
<td>Brachiaria decumbens Stapf</td>
<td>Rearing</td>
<td>Prot./energ.</td>
</tr>
<tr>
<td>3</td>
<td>Alonso et al. (2014)</td>
<td>75</td>
<td>Brachiaria Brizantha cv. Marandu</td>
<td>Rearing</td>
<td>Prot./energ.</td>
</tr>
<tr>
<td>5</td>
<td>Porto et al. (2009)</td>
<td>25</td>
<td>Brachiaria Brizantha cv. Marandu</td>
<td>Rearing</td>
<td>Protein</td>
</tr>
<tr>
<td>6</td>
<td>Nogueira et al. (2015)</td>
<td>39</td>
<td>Brachiaria brizantha e decumbens</td>
<td>Rearing</td>
<td>Protein</td>
</tr>
<tr>
<td>7</td>
<td>Lima et al. (2012)</td>
<td>5</td>
<td>Brachiaria Brizantha cv. Piatã</td>
<td>Rearing</td>
<td>Protein</td>
</tr>
<tr>
<td>8</td>
<td>Sales et al. (2011)</td>
<td>25</td>
<td>Brachiaria decumbens Stapf</td>
<td>Rearing</td>
<td>Protein</td>
</tr>
<tr>
<td>9</td>
<td>Socreppa et al. (2015)</td>
<td>30</td>
<td>Brachiaria Brizantha cv. Marandu</td>
<td>Rearing</td>
<td>Energy</td>
</tr>
<tr>
<td>12</td>
<td>Baroni et al. (2010)</td>
<td>48</td>
<td>Brachiaria Brizantha cv. Marandu</td>
<td>Finishing</td>
<td>Protein</td>
</tr>
<tr>
<td>13</td>
<td>Detman et al. (2004)</td>
<td>25</td>
<td>Brachiaria decumbens Stapf</td>
<td>Finishing</td>
<td>Protein</td>
</tr>
<tr>
<td>14</td>
<td>Botini et al. (2015)</td>
<td>30</td>
<td>Capim Marandu</td>
<td>Finishing</td>
<td>Energy</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>462</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DWG and FLW were analyzed using a forest plot. First, a funnel plot analysis was conducted to assess whether there was publication bias in the meta-analysis. All studies used had a treatment without supplementation, which we combined into a control group for our analysis. The other three treatments: protein, energy, and protein/energy supplementation, were considered subgroups. For each study, the number of events, averages, and standard deviations were tabulated using Excel (Microsoft Office), and analyzed in R (version 3.3.2) using the metacont function, which is included in the meta package. Graphs were built for each variable using the forest function, one for each phase (rearing and finishing). However, the finishing phase protein/energy subgroup only included dispersion data from one study, making it impossible to compare to other subgroups. Thus, this subgroup was removed from the forest plot.

Heterogeneity among the experiments included was quantified using the I$^2$ test (Higgins, Thompson, Deeks, & Altman, 2002), which quantifies the impact of heterogeneity on a meta-analysis using mathematical criteria independently on number of studies and metric effect of the treatment. The random model was chosen due to the heterogeneity of the analyzed results.
Results and Discussion

DWG in the rearing phase was similar across protein, energy, and protein/energy supplementation regimens (Figure 1), and was always higher compared to that of cattle not given supplementation. The forest plot shows the lozenges, representing each type of supplementation in the meta-analysis, align on the positive side of the same axis (p > 0.05), demonstrating a similar response. Garcia, Euclides, Alcalde, Difante and Medeiros (2014) evaluated the performance of B. decumbens ‘Basilisk’-fed crossbred cattle (Braford x Angus x Nellore) supplemented with protein mineral salt 0.2% of the body weight, and reported a weight gain of 0.630 kg, which is close to the mean weight gain we found in cattle receiving supplementation.

Figure 1 also shows that animals receiving supplementation had greater DWG than the control group, with an average increase of 119 g day$^{-1}$ among the subgroups. This finding is associated with a higher nutritional level and biological efficiency in the rearing animals receiving supplementation during the phase of physiological development. Nascimento et al. (2010) showed that the mean...
daily gain of animals given supplementation was 33.4% higher than the gain of the animals receiving only the mineral mixture, which corresponds to an increase of 150 g day\(^{-1}\).

As for the FLW of rearing cattle (Figure 2), the protein/energy and energy supplementation subgroups showed uniform results (p > 0.05). In contrast, protein supplementation resulted in an increase of 28.22 kg compared to control animals. This is likely because as the animals grow, more protein is needed for muscle tissue. Fernandes, Reis and Paes et al. (2010) reported an increase of 30 kg in the final weight of supplemented animals.

For additional weight gain during the rearing phase in supplemented animals, the subgroups showed that cattle receiving protein supplementation had 61.12% and 76.29% more weight gain than animals receiving protein/energy or energy supplements, respectively. Such results demonstrate better efficiency of protein supplementation during the development phase.

Despite the different seasons during which the studies used occurred, Brachiaria did not provide enough nutrients to meet the requirement of animals at this age, regardless of receiving forage supplementation. Therefore, the supplementation strategy can be used when the forage is deficient for specific nutrients, increasing dry-matter consumption and improving digestibility (Koscheck et al., 2011).

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in greater quantity and with higher quality. Thus, the supplementation strategy can be used when the forage is deficient for specific nutrients, increasing dry-matter consumption and improving digestibility (Koscheck et al., 2011).

Animals have lower protein requirements during the finishing phase, resulting in greater energy for fat deposition and improving carcass finishing. Energy supplementation in diets based on good quality forage can improve the efficiency of N use, decreasing the acetate to propionate ratio (A:P), and consequently decreasing methane production (Rivera et al., 2010).

Figure 3 shows DWG in the finishing phase. The two subgroups analyzed for this variable showed similar responses. The two lozenges of the supplements are on the same line, with no difference in daily gain for the two groups. However, even with evident similarity, the DWG of the energy supplementation group is 41.53% higher than the protein group, proving that higher energy levels in the finishing phase result in better animal responses.

Figure 3 also shows a daily gain difference between the groups of supplemented animals compared to those that were finished only in pasture. Protein and energy supplementation showed a gain increase of 102 g day\(^{-1}\) compared to the control group, showing that the use of Brachiaria grazing supplements improves productive performance. In general, cattle graze on forage with low nutritional value, with high levels of indigestible fiber and low levels of crude protein. According to Carvalho et al. (2014), protein supplementation to cattle in tropical forages increases the supply of ammoniacal nitrogen to ruminal microorganisms, increasing forage consumption.
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Figure 4 shows FLW in finishing-phase animals, which was similar to the forest plot of DWG for the same phase. Animals in the supplemented groups presented a balanced performance, demonstrating that energy supplementation did not increase their final weight when compared with protein supplementation. Differently from the animals not receiving supplementation in this period, the subgroups presented an additional FLW of 24.47 kg compared to the control group. As seen in other parameters for this phase of growth, all lozenges are located on the positive (right) side, demonstrating the benefit of either protein or energy supplementation on the performance of cattle grazed in tropical pastures.

Figure 4. Forest plot for final live weight (FLW) of tropical forage-fed finishing-phase cattle that received different supplements.

Conclusions

Dietary protein and/or energetic supplementations for cattle grazed on Brachiaria improves the performance of these animals. Protein supplementation beneficially effects the FLW of animals specifically during the rearing phase.

References


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