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Effect Of Mixing Time On The Bromatological Composition Of The Diet Of Confined Beef Cattle

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Abstract
Brazil has approximately 200 million hectares of pastureland, and livestock farming has been challenged to produce a product of high quality at a low price and in a sustainable way. In particular, the beef cattle confinement strategy is currently being widely used due to the possibility of reducing the production cycle and raising more volume to supply domestic and foreign market demand. In an effort to improve efficiency by fine-tuning the feed management processes in the feedlot, the current study sought to minimize losses in the quality of the feed provided to the animals at the trough, to provide a feed that was as close as possible to the formulated diet, by evaluating the feed mixing time, which is a significant intrinsic factor in the process, allowing for greater feed homogeneity. The study aimed to evaluate different mixing times in the mixing wagon on the chemical-bromatological composition of feed for feedlot cattle. The treatments were five mixing times: Time 1 (0 minutes of beating after loading the wagon); Time 2 (1 minute of beating); Time 3 (2 minutes of beating); Time 4 (3 minutes of beating) and Time 5 (4 minutes of beating). The experimental design was entirely randomized with five treatments and six replications, repeated on three consecutive days. The mixing time was timed after loading the mixing wagon. Then plastic trays were distributed on the trough line, one for each repetition, and a 1 kg sample was collected and stored for later analysis. The content of dry matter (DM), mineral matter (MM), and crude protein (CP) were not influenced by the mixing time of the feed, but the content of insoluble fiber in neutral detergent increased with a shorter mixing time. It was concluded that at least a 2-minute mixing time of the mixing wagon is necessary after loading the ingredients.
Keywords: *chemical composition; diet; mixing time*

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I. Introduction

Brazil has approximately 200 million hectares of pasture area (IBGE, 2020). In recent years, the country has reduced the area occupied by cattle and increased meat production (ABIEC, 2019). The challenge is to produce a product that is quality, low cost, and sustainable (DETMANN et al., 2004).

In the country, 42.31 million heads of cattle are slaughtered annually, producing 10.79 million tons of meat, and 95% of this production comes from animals finished on pasture (ABIEC, 2019).

In the pasture, factors such as the seasonality of forage production throughout the year and the lack of forage management cause animal malnutrition, allowing extensive systems to present low productivity rates, with a direct impact on increasing the age of slaughter (SANTOS et al., 2004).

However, the adoption of strategies such as the confinement of beef cattle is a favorable practice to meet the demand of the domestic and foreign markets due to the efficiency of nutritional management that this practice provides for the development of animals (LAZARINI et al., 2014).

The success of this strategy is linked to several assertive factors, such as the genetics of the animals, adequate facilities, management of the animals during the confined period, formulation of the diet based on nutritional requirements (estimated dry matter consumption and average daily gain), and control of feed supply (COSTA JÚNIOR, 2018). Regarding feed supply, an important point that must be considered in the process is the feed mixing efficiency.

Therefore, providing animals with adequately formulated and mixed feed is essential to maintain stable patterns of feed intake and performance of confined animals (CLARK et al., 2007; WAGNER, 1995). The mixing of ingredients depends on the correct time to obtain a product (feed) with good quality and homogeneity according to the formulation prediction (LIMA & NONES, 1997).

The provision of consistent, high-quality, and homogeneous feed can significantly enhance the profitability of the system, given that feed costs constitute a substantial portion of the total confinement costs. As Sova et al. (2014) suggest, implementing measures that improve the total ration mix can yield positive effects on herd performance, underscoring the practical implications of our research findings.

Given the scarcity of information on the optimal time for mixing feeds in beef cattle confinements, there is a pressing need to delve into this area of research. The present study, therefore, sets out to evaluate the impact of mixing time on the bromatological characteristics of the diet of confined beef cattle, a topic of significant importance in the field of animal science and livestock management.

II. Material And Methods

The study was conducted by the Federal Institute of Rondônia in a commercial beef cattle confinement, Raísa farm, located in Presidente Médici—RO, in partnership with Vitamais Nutrição Animal LTDA. The collection period took place in September 2021.

The experimental design was completely randomized (DIC) with five treatments (beating time) and six replications (collection points on the trough line), in which the influence of five mixing times of the beef cattle confinement diet on the According to the chemical-bromatological characteristics, the five treatments will be: time 1 (0 minutes of beating after loading the wagon); tempo 2 (1 minute beat); tempo 3 (2 minutes of beat); time 4 (3 minutes of beating) and time 5 (4 minutes of beating).

According to BR Corte (2016) (Valadares Filho et al., 2016), the diet was formulated to meet the nutritional demands of cattle confined in the finishing phase. The diet consisted of cotton briquettes, cottonseed, pelleted soybean hulls, ground corn grain, dried distillers grain with solubles (DDGS), and mineral core (Table 1).

The ingredient loading order was the same for all treatments. The KUHN model mixing wagon, vertical RA series 100, with a capacity of 4 tons, and Helix tipping rotor with central opening was used to mix the diets.

Table 1 - Diet formulation.

Ingredients	Dry matter
Cotton Briquette	11.79%
Cottonseed	14.86%
Soy Hull	7.91%
Ground Corn Grain	48.30%
DDGS[1]	14.86%
Core	2.26%
Total	100%

[1]DDGS: dry distillers grain with solubles

The ingredients were loaded into the mixing wagon with a John Deere model 6125 tractor. During loading, the mixing wagon was coupled to another John Deere model 6115 tractor, driven at a speed of 1800 rpm.

The ingredients were weighed using a scale attached to the mixing wagon, where the operator saw the weighing of each ingredient. To ensure attendance, the operator was the same for all loads.

After loading the last ingredient, the respective mixing time was timed. In the end, the rotation of the mixing wagon was deactivated until it reached the trough lines, where it was activated again to begin distributing the feed, with a rotation of 750 rpm. For all mixing times, the time for loading the wagon and for distribution to the trough lines was maintained.

Samples of the feed supplied according to each mixing time were collected along the trough lines at six pre-defined points over three consecutive days.

At the six pre-defined points on the trough line, plastic trays were distributed so that the feed could be poured and collected before the animals had access. The samples were then stored and identified in bags with a capacity of 1 kg. There were 90 samples in total, coming from 5 treatments with six replications and three consecutive days.

Samples of each ingredient that made up the formulated diet were also collected. At the end of the collections, the samples were ground in a Willey mill, using a 1.5 mm sieve to carry out qualitative laboratory analyses in accordance with the procedures of the Brazilian National Institute of Science and Technology in Animal Science (INCT-CA, Detmann et al. 2012), which consisted of analyzing the concentrations of nutritional contents of dry matter (DM; INCT-CA G-003/1), crude protein (CP; INCTCA N-001/ 1), organic matter (MO), and ash (MM; INCT-CA M-001/1).

Neutral detergent insoluble fiber (NDF) was determined according to the methodology described by Van Soest (1994).

The results obtained in the analyses were subjected to analysis of variance using the Mixed procedure of the Statistical Analysis System, version 9.1.3, using the Tukey test, at a level of 5% significance, and the coefficients of variation were also calculated (CV).

III. Results And Discussion

Confinement diets with a higher level of concentrate (>80% DM) tend to reduce discrepancies in chemical composition according to mixing time in the mixing car due to concentrated feeds having a lower level of moisture and similar particle size, which makes it easier to mix your diet.

In Table 2, the effects of mixing on the chemical-bromatological composition of the diet can be seen in relation to the beating times after loading the food into the mixing wagon. As for the Dry Matter (DM) content, mixing times did not influence the dry matter content of the diet; this possibly occurred because the foods used in the diet have a very close DM content, so if the mixture is not perfect, no change is expected (Table 2), as well as the values of coefficients of variation between treatments, had low values (Table 3).

Protein is one of the most important components in the ruminant diet, essential for the animal's growth, productivity, and reproductive factors (Hoffman, 2020).

As for the content of Mineral Matter and Crude Protein, they were not influenced by mixing times, similar to what occurred with the DM content of the diet. Lazarini et al. (2014), in a study evaluating the bromatological composition of the diet in relation to the beating time using a BULLDOG model mixing wagon from the manufacturer STORTI, where the times evaluated were 2, 4, 6, and 8 minutes, observed that the time of 4 minutes was which converted into CP and TDN values more similar to those of the formulated diet.

Table 2 - Chemical-bromatological evaluation of the feed at different mixing times in the mixing wagon.

Items	Beat time after charging[1]					EPM	P-value		
	Time 1	Time 2	Time 3	Time 4	Time 5		Time	Day	T*D
DM, %	85.79	85.63	86.45	85.5	86.17	0.431	0.52	0.44	0.1
MM	5.56	5.53	5.32	6.54	5.18	0.653	0.61	0.07	0.42
NDF	47.91[a]	46.40[ab]	44.35[ab]	45.25[ab]	43.45[b]	0.845	0.01	<0.01	0.01
CP	14.56	14.68	14.53	14.36	14.53	0.438	0.99	0.69	0.32

[1]time 1 (0 minute beat after wagon loading); time 2 (1 beat minute); time 3 (2 beat minutes); time 4 (3 beat minutes) and time 5 (4 beat minutes)

França et al. (2022), in their experiment, evaluated the mixing quality using a rotor wagon with different loads, with and without pre-mixing before loading, with a mixing wagon also of the BULLDOG model and a mixing time pre-defined by the manufacturer of 3 minutes, found no significant difference between CP levels.

Table 3 – Coefficient of variation of the chemical-bromatological composition of the feed at different mixing times in the mixing wagon.

Itens	Beat time after charging[1]				
	Time 1	Time 2	Time 3	Time 4	Time 5
DM, %	1.80%	2.74%	1.80%	1.46%	1.93%
MM	11.05%	9.82%	8.06%	5.61%	5.67%
NDF	8.32%	9.09%	6.97%	5,40%	6.17%
CP	11.89%	12.78%	10.21%	6.71%	7.09%

[1]time 1 (0 minute beat after wagon loading); time 2 (1 beat minute); time 3 (2 beat minutes); time 4 (3 beat minutes) and time 5 (4 beat minutes)

However, it should be noted that the coefficients of variation values numerically reduced with longer mixing time for the components MM, FDN, and PB, which indicates that at least 3 minutes of mixing is necessary for greater homogeneity of the mixture diet.

In the current study, the content of neutral detergent insoluble fiber (NDF) was influenced by the feeding time, so the shorter the mixing time, the higher the NDF content of the feed; this was possibly implied by foods with lower mixing capacity, such as cotton boll, which contained more NDF. A compromised mixture could influence the dispersion of food particles and the change in chemical compounds in the diet.

According to Malafaia et al. (2011), some disorders, such as a decrease in rumination, chewing, and salivation activities, can be caused by a deficiency of physically adequate fiber in the diet, thus decreasing the animals' performance. Therefore, a time guide that better expresses the NDF value of the diet would be engaging and highlight the more real value of the food provided to the animals.

However, França et al. (2022), evaluating the NDF content with and without pre-mixing the ingredients before being placed in the mixing wagon, found no significant differences in their results.

IV. Conclusion

At least 3 minutes of mixing time is required in the mixing car after loading the ingredientes.

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