Beef calf production: Consumption and cost-effectiveness – A Mini-Review

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Abstract

The objective of this study was to analyze different forms of supplementation for beef calves, considering the relationship between consumption and cost-benefit, aiming at weaning performance. High concentrate levels may reduce forage consumption, which is undesirable as supplementation should increase the efficiency of forage and milk use. The ideal amount of concentrate is 0.5% of the calves' body mass, without changing feed and milk consumption. The supplement must contain between 8% and 30% protein to avoid metabolic disorders and ensure good performance. Adding 10% salt to the concentrate increases economic viability, even with lower consumption, resulting in greater gains and profitability. Adequate supplementation guarantees greater mass at weaning and better daily gain, as long as nutritional management is balanced and economically viable.

Keywords: performance, weaning, supplementation, beef quality, productivity, supplementary feeding, sustainability.

Produção de bezerros de corte: Consumo e custo-benefício – Uma Mini-Revisão

Resumo

O objetivo desse estudo foi analisar diferentes formas de suplementação para bezerros de corte, considerando a relação entre consumo e custo-benefício, visando o desempenho sobre o desmame. Níveis elevados de concentrado podem reduzir o consumo de forragem, o que é indesejável, pois a suplementação deve aumentar a eficiência do uso de forragem e leite. A quantidade ideal de concentrado é de 0,5% sobre a massa corporal dos bezerros, sem alterar o consumo de ração e leite. O suplemento deve conter entre 8% e 30% em proteínas para evitar distúrbios metabólicos e garantir um bom desempenho. Adicionar 10% de sal ao concentrado aumenta a viabilidade econômica, mesmo com menor consumo, resultando em maiores ganhos e rentabilidade. A suplementação adequada garante maior massa ao desmame e melhor ganho diário, desde que o manejo nutricional seja equilibrado e economicamente viável.

Palavras-chave: performance, weaning, supplementation, qualidade da carne, produtividade, alimentação suplementar, sustentabilidade.

1. Introduction

Within beef cattle farming, one of the factors that can improve the economy of the cow-calf system is the increase in the weaning weight of calves. Along with this, some other advantages are obtained, including the reduction of time for slaughter and the shorter period for puberty of heifers (Carvalho et al., 2018; Michetti et al., 2022). A fact observed in calves after three months of age is that milk is not able to meet the nutritional demands required due to the rapid growth potential in the initial phase, therefore, the diet tends to depend heavily on the quality of the pasture, that during the transition from the rainy to the dry season reduces both the nutritional value and forage mass, in contrast, the calves' demands are in constant progression (Costa e Silva et al., 2015).

This rapid growth rate of calves requires efficient feeding management, and for this to occur, supplementation is suggested. The economic viability of the system using supplements depends on factors such as supplement cost,

calf price, feed efficiency of supplemented calves compared to non-supplemented calves, animal genetics, ingestion and digestion of forage and milk (Aguiar et al., 2015).

Supplementation must be based on the level of production used on the rural property, as within economics, the balance between investment and profit obtained is assessed. According to Detmann et al. (2005), an efficient supplementation program for calves must add nutrients to the calf's diet and not replace the nutrients naturally obtained through the consumption of forage and milk, this substitution being the main cause of the low economic efficiency of calf supplementation, where the high consumption of concentrate is considered the main problem, in this sense, Sampaio et al. (2002), proposes that to reduce this uneconomical nature of supplementation, limiting consumption could be an alternative used.

Therefore, the objective of this review was to evaluate the different forms of supplementation of beef calves, evaluating the relationship between consumption and economics in the use of this feeding management to obtain animals with better performance at weaning.

2. Material and Methods

2.1 Type of search

In this study in question, a bibliographic review was used as a research method, where the results of published, scientific research were sought to provide greater familiarity with the topic addressed. The survey of scientific production on the proposed topic was carried out through databases available electronically on websites such as Scientific Library Online (SciELO), Scopus, Web of Science, and Google Scholar.

2.2 Selection

The selection searched for articles in journals between the years 1980 and 2024, however, some works published before this period were considered, as they dealt with the aforementioned topic. Next, an exploratory reading of the content found was carried out, obtaining a global view of the material of interest. The selected articles were in Portuguese and English and submitted for full reading and analysis. Articles, books, and theses with themes not associated with the research were used as exclusion criteria.

3. Bibliographic review

3.1 Beef cattle

One of the main purposes in beef cattle farming, in raising calves, is to wean the heavier calf, allowing both the slaughter of males and the mating of heifers under 16 months old. According to Paulino et al. (2012), calves in the lactation phase are more efficient in absorbing nutrients, ensuring a greater capacity for weight gain. According to Geiger et al. (2019) and van Niekerk et al. (2021), research has demonstrated positive effects of feeding colostrum or colostrum or IgG supplementation after the first day of life on the health and development of calves. For example, supplementing calves with colostrum replacer to provide 20 g of IgG in milk replacer (MR) from birth to 14 days results in lower mortality rates and antibiotic treatments for diarrhea.

Ansotegui et al. (1991) reported milk production influenced calf growth up to 60 d postpartum, with no differences in calf ADG after peak lactation. In agreement, Edwards et al. (2017) reported calf d-58 BW was greater in calves from moderate and high-milking cows compared with low-milking cows; however, calf BW at weaning was similar among milk production groups. The lack of increased calf growth with additional milk after d 60 in the studies by Edwards et al. (2017) and Hatfield et al. (1989) may be explained by differences in milk and forage intake and decreased efficiency of converting milk to calf gain in calves (Montano Bermudez et al., 1990a,b; Mulliniks et al., 2020).

3.2 Age of calves

The age and consumption of calves are factors that impact the final performance of the animals therefore, it is expected that increasing supplementation during this period, based on body weight, may improve performance compared to fixed amounts provided for a set time (Valente et al., 2014). Almeida et al. (2018), to evaluate the effects of supplementation on calf cutting, using a supplement with 20% crude protein and supplies of 0.0, 0.2, 0.4, and 0.6% of body weight, of Nelore animals, observed that supplementation provided an increase in average daily earnings, attributing this fact to greater availability of energy available by increasing the supply of

concentrate.

A successful method is the use of a substitute product widely used in an attempt to reduce farm costs, to gain weight among calves compared to those that receive only whole milk (Boito et al., 2015; Caçolli; Vieira, 2022). According to Thornsberry et al. (2016), Grice et al. (2022), and (Silva et al., 2023), alternative protein sources in milk replacer (MR) have been a topic of research for many years as the price of whey proteins, the main component in MR, has increased along with the human consumption of whey proteins.

According to Kharitonov et al. (2020), depending on the combination, mainly of the protein components incorporated in the feed, a protein component is provided, which is the main material in the constructive metabolism of a rapidly developing organism, in this case, calves. Still in this study, Kharitonov et al. (2020), advocates standardized nutrition that provides for accounting for the necessary quantity and quality of protein in the feed provided to growing animals. A serious problem is the use of low-quality protein in the diet, used in livestock farming, which is characterized by a high content of metabolized protein, which leads to excessive formation of a by-product (ammonia) in the rumen that is not involved in the synthesis of microbial proteins and excreted in urine with additional energy costs. This disturbance leads to excessive consumption of forage proteins and is accompanied by metabolic disorders, deterioration of the animal's health and leads to higher production costs. An unbalanced diet, especially of young calves, leads to the development of all kinds of rumen pathologies and prevents the implementation of pedigree qualities.

3.3 Nutritional supplement for calves

The differences found by the author for the greater performance of supplemented animals is due to higher levels of supplementation, observed through the greater consumption of dry matter than supplement, which caused a reduction in forage consumption, thus showing that the greater the supplementation, the tendency is to reduce forage consumption, due to the effect replacement occurred by consuming the supplement (Porto et al., 2008).

Detmann et al. (2014), attribute this fact to a maximum value of tropical forage intake of 288 g CP kg^{-1}, Therefore, it is concluded that by providing greater amounts of supplement, there would be an imbalance in the ratio of crude protein consumption, which would lead to a decrease in forage consumption by metabolite mechanisms.

Similar results were found by Lopes et al. (2017), who worked with supplements with 25% CP and supplies of 0; 0.3; 0.6, and 0.9% PC, where they observed a greater average daily gain of supplemented animals, compared to animals in the group control, in addition to increased consumption of the supplement and consequent decrease in consumption of forage, thus having a substitutive effect with a reduction of around 25% in consumption of forage for the larger amounts of supplements provided.

In contrast, Barros et al. (2015), evaluating supplements with 25% protein gross and supplies of 0, 0.2, 0.4, and 0.6% of BW, observed that the use of supplementation improved the performance of calves compared to animals in the control group, however, did not observe a substitutive effect of forage by the supplement at the highest level of supply studied.

3.4 Protein level in calf nutrition

Another extremely important factor when supplementing calves is the crude protein level of the supplement. Nitrogen compounds are important mainly during the dry seasons of the year, where forage protein levels are lower, thus limiting the activity of ruminal microorganisms, affecting the digestibility, consumption, and quality of forage, resulting in poor performance of animals (Detmann et al., 2014). Therefore, some studies were carried out to evaluate the effect of supplementation with different levels of crude protein on the performance of lactating calves.

Cardenas et al. (2015) evaluating supplements with 7.3, 16.7, 25.6, 34.6 and 43.2% CP, with a fixed supply of 0.5 kg animal, observed that there was an increase in the consumption of crude protein by animals, explained by the greater contribution of this nutrient by the supplement, where no differences were observed in milk and forage consumption, the sources of this nutrient, the average daily gain was greater for calves supplemented, to both levels. Similar results were described by Lopes et al. (2014), with levels of crude protein of 8, 19, 30, and 41%, but set a dietary protein level between 8 and 30% as this could partially replace the intake of lower quality pasture nutritional, increasing the digestibility of the diet.

Despite the notable efficiency in the use of supplementation for calves to ensure a greater weaning weight, some

points must be considered, as a factor that can influence the economics of this type of management is the consumption of this supplement through supply levels and likely substitutive effect of forage and milk, through supplementation, therefore, in addition to performance, economic viability must be evaluated.

In this context Sampaio et al. (2002), carried out a study to evaluate the performance of beef calves receiving supplementation, aiming to reduce feed intake supplement through the use of salt (NaCl) in the supplement at levels of 5 and 10%. It is observed that the SAL5 treatment showed a higher intake of concentrate by calves with 0.73 kg/day^{-1}, compared to 0.47 kg/day of the SAL10 treatment, but although there was a lower consumption, the calves of the SAL10 treatment showed a higher average daily gain, with 0.98 kg/day^{-1}.

These results were attributed to the effect of replacing forage with concentrated in the SAL5 treatment, which made it difficult for calves to achieve better feed efficiency, according to the author, this process occurs because, if quality forage and milk in ideal quantities, the calves will gain weight up to their genetic potential. Explored, therefore, the lower efficiency caused by replacing forage with supplement supplied in free quantities, reduces the feed conversion of these animals, while for animals in the SAL10 treatment, with lower consumption, the additive (and not substitutive) power of supplement provided slightly better performance, combined with a higher intake of forage and milk.

From an economic point of view, viability must be based on the additional gain of supplemented animals compared to non-supplemented animals, observing the results obtained by Sampaio et al. (2002), we note some important points for the adoption of limiting consumption in supplements. The SAL5 treatment, because it had a greater consumption, provided a higher supplementation cost, presenting a difference in gain of 7.2 kg/animal, which generated a negative monthly remuneration rate of -12.5%, whereas, for the animals in this treatment to present zero profit, this differential should be 10.8 kg/animal^{-1}.

In the SAL10 treatment, presenting lower consumption and cost of supplementation, there was a difference of 9.0 kg/animal^{-1}, a value already above the stipulated to obtain zero profitability and providing profitability of 6% per month, thus demonstrating the economic viability of adding 10% salt to the supplement when compared to 5% salt.

4. Conclusion

The use of supplementation in beef calves ensures greater weight at weaning, increasing the animals' average daily gain, as long as nutritional management is balanced according to the animal's needs and the economic viability of the system is favorable. Supplementation should complement the diet, without replacing the consumption of forage dry matter and milk, which are fundamental foods in the calves' diet.

It is essential to ensure that the supplement contains a protein content between 8% and 30%, to prevent metabolic disorders, avoid substitutions in the diet, and, consequently, preserve the animals' performance. Adding 10% salt to the concentrate promotes greater economic efficiency in supplemented animals, resulting in increased weight gain and profitability, even with lower consumption.

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7. Authors' contributions

Ingridy de Carvalho Dutra: article writing and submission. *Fabiano Ferreira da Silva*: scientific corrections. *Aureliano José Vieira Pires*: scientific corrections. *Wêndel Bispo Santos e Santos*: reading the articles and spelling review. *Geovana de Carvalho Dutra*: reading the articles and spelling review. *Nadjane Vieira da Silva*: reading the articles and spelling review. *Mateus Pereira Sousa*: reading the articles and spelling review. *Hackson Vieira da Silva*: reading the articles and spelling review.

8. Conflicts of interest

There are no conflicts of interest.

9. Ethical approval

Not applicable.

10. References

Abitante, G., Leme, P. R., Carlis, M. S. P., Ramírez-Zamudio, G. D., Gomes, B. I. P., Andrade, L. B., Goulart, R. S., Pugliesi, G., Netto, A. S., Dahlen, C. R., & Silva, S. L. Effects of early weaning on performance and carcass quality of Nellore young bulls. *Animals*, 14(5), 779. https://doi.org/10.3390/ani14050779

Aguiar, A. D., Vendramini, J. M. B., Arthington, J. D., Sollenberger, L. E., Caputti, G., Sanchez, J. M. D., Cunha, O. F. R., & Silva, W. L. (2015). Limited creep-feeding supplementation effects on performance of beef cows and calves grazing limpograss pastures. *Livestock Science*, 180, 129-133. https://doi.org/10.1016/j.livsci.2015.08.008

Almeida, D. M., Marcondes, M. I., Rennó, L. N., Martins, L. S., Marquez, D. E. C., Villadiego, F. C., Saldarriaga, F. V., Ortega, R. M., Moreno, D. P. S., Lopes, S. A., Cardozo, M. A., & Paulino, M. F. (2018). Supplementation strategies for Nellore female calves in creep feeding to improve the performance: nutritional and metabolic responses. *Tropical Animal Health and Production*, 50(8), 1779-1785.

Ansotegui, R. P., Havstad, K. M., Wallace, J. D., & Hallford, D. M. (1991). Effects of milk intake on forage intake and performance of suckling range calves. *Journal of Animal Science*, 69(3), 899-904. https://doi.org/10.2527/1991.693899x.

Barros, L. V., Paulino, M. F., Marques, D. E. C., Cabral, C. H. A., Silva, F. G., Caldeira, D. S. A., Lopes, S. A., & Moura, F. H. (2015). Supplementation of suckling beef calves on a creep-feeding system and nutritional evaluation of lactating beef dams. *Semina: Ciências Agrárias*, 36(5), 3431-3443. https://doi.org/10.5433/1679-0359.2015v36n5p3431

Boito, B., Menezes, L. F. G., Ziech, M. F., Kuss, F., Lisbinski, E., & Fiorelli, A. (2015). Uso de sucedâneo em substituição ao leite no desempenho de bezerros da raça holandesa durantea cria e recria. *Ciência Animal Brasileira*, 16(4), 498-507. https://doi.org/10.1590/1089-6891v16i432297

Caçolli, A. S., & Vieira, P. R. P. (2022). Uso de sucedâneo lácteo na criação de bezerros leiteiros; uma revisão integrativa da literatura. *Scientia Generalis*, 3(2), 301-315. https://www.scientiageneralis.com.br/index.php/SG/article/view/459

Cardenas, J. E. G., Paulino, M. F., Lopes, S. A., Silva, A. G., Barros, L., & Valente, E. E. L. (2015). Performance productive, intake and digestibility of nursing calves raised on pasture supplemented with different levels of crude protein. *Archivos de Zootecnia*, 64(246), 167-174.

Carvalho, V. V. (2018). Reweaning nutritional effects of supplements on performance of suckling beef calves grazing tropical pastures. Tese de Doutorado em Ciência Animal pela Universidade Federal de Viçosa – UFV, Minas Gerais, Brasil, 54 f.

Costa e Silva, L. F., Engle, T. E., Valadares Filho, S. C., Rotta, P. P., Villadiego, F. A. C., Silva, F. A. S., Martins, E. C., Silva, L. H. R., & Paulino, M. F. (2015). Nellore cows and their calves during the lactation period: performance, intake, milk composition, and total apparent digestibility. *Tropical Animal Health and Production*, 47(4), 735-741.

Detmann, E., Paulino, M. F., Valadares Filho, S. C., Cecon, P. R., Zervoudakis, J. T., Cabral, L. S., Gonçalves, L. C., & Valadares, R. F. D. (2005). Níveis de proteína em suplementos para terminação de bovinos em pastejo durante o período de transição seca/águas: digestibilidade aparente e parâmetros do metabolismo ruminal e dos compostos nitrogenados. *Revista Brasileira de Zootecnia*, 34(4), 1380-1391. https://www.scielo.br/j/rbz/a/rvsHKJGHsHkGtLVSwxz8Ykv/?format=pdf

Detmann, E., Valente, É. E. L., Batista, E. D., & Huhtanen, P. (2014). An evaluation of performance and efficiency of nitrogen utilization in cattle feed tropical grass pastures with supplementation. *Livestock Science*, 162(1), 141-153. https://doi.org/10.1016/j.livsci.2014.01.029

Edwards, S. R., Hobbs, J. D., & Mulliniks, J. T. (2017). High milk production decreases cow-calf productivity within a highly available feed resource environment. *Translational Animal Science*, 1(1), 54-59. https://doi.org/10.2527/tas2016.0006

Geiger, A. J., Leonardi, C., & Lago, A. (2019). Supplementing dairy calves with colostral immunoglobulins for 14 days reduces death loss and antibiotic usage. *Journal of Dairy Science*, 102, 182.

Grice, K. D., Glosson, K. M., & Drackley, J. K. (2020). Effects of feeding frequency and protein source in milk replacer for Holstein calves. *Journal of Dairy Science*, 103, 10048-10059. https://doi.org/10.3168/jds.2020-19041

Hatfield, P. G., Clanton, D. C., Eskridge, K. M., & Sanson, D. W. (1989). Forage intake by lactating beef cows differing in potential for milk production. Journal of Animal Science, 67(11), 3018-3027. https://doi.org/10.2527/jas1989.67113018x

Kharitonov, E. L., Ostrenko, K. S., Lemiasheuski, V. O., & Galochkina, V. P. (2020). Prevention of protein deficiency in dairy bull calves during fattening. *E3S Web of Conferences*, 224, 04046. https://doi.org/10.1051/e3sconf/202022404046

Lopes, S. A., Paulino, M. F., Detmann, E., Valadares Filho, S. C., Valente, E. E. L., Barros, L. V., Cardenas, J. E. G., Almeida, D. M., Martins, L. S., & Silva, A. G. (2014). Supplementation of suckling beef calves with different levels of crude protein on tropical pasture. *Tropical Animal Health and Production*, 46(2), 379-384.

Lopes, S. A., Paulino, M. F., Detmann, E., Valente, E. E. L., Rennó, L. N., Valadares, R. F. D., Cardenas, J. E. G., Almeida, D. M., Moura, F. H., & Oliveira, C. A. S. (2017). Evaluation of supplementation plans for suckling beef calves managed on tropical pasture. *Semina: Ciências Agrárias*, 38(2), 1027-1039. https://doi.org/10.5433/1679-0359.2017v38n2p1027

Michetti, M., Reis, J. C., Hamoi, M. Y. T., & Lopes, L. B. (2022). Análise da co-integração entre a pecuária de leite e corte em Mato Grosso. *Nativa*, 10(1), 32-39. https://doi.org/10.31413/nativa.v10i1.13130

Montaño-Bermudez, M., & Nielsen, M. K. (1990a). Biological efficiency to weaning and to slaughter of crossbred beef cattle with different genetic potential for milk. Journal of Animal Science, 68, 2297-2309. https://doi.org/10.2527/1990.6882297x

Montaño-Bermudez, M., Nielsen, M. K., & Deutscher, G. H. (1990b). Energy requirements for maintenance of crossbred beef cattle with different genetic potential for milk. *Journal of Animal Science*, 68, 2279-2288. https://doi.org/10.2527/1990.6882279x

Mulliniks, J. T., Beard, J. K., & King, T. M. (2020). Invited review: Effects of selection for milk production on cow-calf productivity and profitability in beef production systems. *Applied Animal Science*, 36(1), 70-77. https://doi.org/10.15232/aas.2019-01883

Paulino, M. F., Detmann, E., Silva, A. G., & Almeida, D. M. (2012). Bovinocultura de alto desempenho com sustentabilidade. *In*: Simpósio de Produção de Gado de Corte, 8(2012), 183-196.

Porto, M. O., Paulino, M. F., Valadares Filho, S. C., Sales, M. F. L., Detmann, E., & Cavali, J. (2008). Formas de utilização do milho em suplementos para novilhos na fase de terminação em pastagem no período das águas: desempenho e parâmetros nutricionais. *Revista Brasileira de Zootecnia*, 37(12), 2251-2260. https://www.scielo.br/j/rbz/a/JG45VqmFVh6DSgz3M7YfWnd/?format=pdf

Sampaio, A. A. M., Brito, R. M. D., Cruz, G. M. D., Alencar, M. M. D., Barbosa, P. F., & Barbosa, R. T. (2002). Utilização de NaCl no suplemento como alternativa para viabilizar o sistema de alimentação de bezerros em *Creep-Feeding*[1]. *Revista Brasileira de Zootecnia*, 31(1), 164-172. https://doi.org/10.1590/S1516-35982002000100019

Silva, E. P., Ghedini, C. P., Ferro, M. M., Freire, J. M., Souza, J. G., Costa, R. V., & De Moura, D. C. (2023). Estratégias nutricionais para aumentar as propriedades nutracêuticas do leite: concentrações de enterolactona e ácido linoleico conjugado. *Nativa*, 9(4), 481-494. https://doi.org/10.31413/nativa.v9i4.11988

Thornsberry, R. M., Wood, D., Kertz, A. F., & Hutcheson, D. (2016). Alternative ingredients in calf milk replace – A review for bovine practitioners. *The Bovine Practitioner*, 50(1), 1-24. https://doi.org/10.21423/bovine-vol50no1p65-88

Valente, E. E. L., Paulino, M. F., Barros, L. V., Almeida, D. M., Martins, L. S., & Cabral, C. H. A. (2014). Nutritional evaluation of young bulls on tropical pasture receiving supplements with different protein: carbohydrate ratios. *Asian-Australasian Journal of Animal Sciences*, 27(10), 1452. https://doi.org/10.5713%2Fajas.2014.14085

van Niekerk, J. K., Fischer-Tlustos, A. J., Wilms, J. N., Hare, K. S., Wlboren, A. C., Lopez, A. J., Yohe, T. T., Cangiano, L. R., Leal, L. N., & Steele, M. A. ADSA *Foundation scholar award*: New frontiers in calf and

heifer nutrition – From conception to puberty. *Journal Dairy Science*, 104, 8341-8362. https://doi.org/10.3168/jds.2020-20004

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