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Research Article

Effect of administration of two commercial formulations based on bovine recombinant somatotropin on the productive and economic performance of dairy cows

Efeito da administração de duas formulações comerciais à base de somatotropina recombinante bovina no desempenho produtivo e econômico de vacas leiteiras

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ABSTRACT

The aim of this study was to evaluate the effect of administering two commercial formulations based on recombinant bovine somatotropin (rbST) on the performance of dairy cows. Fifty-four Girolando cows were used, distributed across three treatments. The first group (n=17) received 500 mg of Sometribove zinc (1.4 ml of Lactotropin® Elanco) every 14 days. The second group (n=19) received 500 mg of rbST (2 ml of Boostin® MSD Animal Health) every 14 days. The third group (n=18) did not receive rbST (control). Milk production was measured every ten days, from 109 to 172DIL, twice a day at 12-hour intervals. Milk production was evaluated as a repeated measure over time, referring to the moments of data collection (time) according to each treatment, as well as the Treatment*Time interaction, using the Repeated command generated by the Mixed procedure of SAS. The SAS LSMeans mean test was used to compare treatments, using the SAS Glimmix procedure. It was found that there was no statistical difference between cows that received Lactotropin® and those in the Boostin® group; however, both showed superior results compared to the control group. The average increase in production with Boostin compared to the control was 3.74 L/cow/day, while Lactotropin was 3.29 L/cow/day. Considering the values of each dose, R$18.50 and R$33.00 respectively, and the sale price per liter of milk produced of R$2.05. We can see from the results obtained that Boostin provides a profit margin of R$6.35/cow/day for every R$1.32 invested. While Lactotropin requires an investment of R$2.36, generating a profit margin of R$4.39/cow/day. Therefore, the most viable option to use will be Boostin, which has a lower commercial value, generating a higher profit margin.

KEYWORDS: Boostin. Lactotropin. Milk production. Economic viability.

RESUMO

The objective was to evaluate the effect of administering two commercial formulations based on recombinant bovine somatotropin (rbST) on the performance of dairy cows. Foram utilizadas 54 vacas da raça Girolando, distribuídos em três tratamentos. O primeiro grupo (n=17) recebeu a aplicação de 500 mg de Sometribove zinco (1,4 ml de Lactotropin® Elanco) a cada 14 dias. O segundo grupo (n=19) recebeu aplicação de 500 mg de rbST (2 ml de Boostin® MSD Saúde Animal) a cada 14 dias. O terceiro grupo (n=18) não receberam aplicação de rbST (controle). Foram submetidas a aferição da produção de leite a cada dez dias, no período de 109 a 172 DIL, duas vezes ao dia e com intervalo de 12h. A produção de leite foi avaliada como medida repetida no tempo, referentes aos momentos de colheita dos dados (tempo) de acordo com cada

tratamento, bem como a interação Tratamento*Tempo, utilizando-se o comando Repeated gerado pelo procedimento Mixed do SAS. O teste de média LSMeans do SAS foi utilizado para comparar os tratamentos, por procedimento Glimmix do SAS. Verificou-se que não houve diferença estatística entre vacas que receberam a aplicação Lactotropin® e aquelas do grupo Boostin® porém, ambos apresentaram resultados superiores em relação ao controle. A produção de incremento médio do Boostin em relação ao controle foi de 3,74L/vaca/dia, já o Lactotropin foi de 3,29L/vaca/dia. Considerando os valores de cada dose, R$18,50 e R$33,00 respectivamente, e o valor de venda do litro do leite produzido de R$2,05. Podemos observar com os resultados obtidos, que o Boostin proporciona uma margem de lucro de R$6,35/vaca/dia, para cada R$1,32 investidos. Enquanto o Lactotropin exige um investimento de R$2,36 que geram uma margem de lucro de R$4,39/vaca/dia. Dessa forma, a mais viável a ser utilizada será o Boostin, que possui menor valor comercial, gerando maior margem de lucro.
PALAVRAS-CHAVE: Boostin. Lactotropin. Produção de leite. Viabilidade econômica.

INTRODUCTION

Brazilian dairy farming contributes significantly to the country's economy, playing an important role in generating employment and income in the agricultural sector (ALMEIDA & BACHA 2021). However, it faces challenges in balancing the production system with the significant increase in production costs in order to maintain profit margins that guarantee minimum profitability (DÍAZ et al. 2020).

Increased milk production allows for cost dilution, providing opportunities to generate greater profitability in dairy farming (FERREIRA et al. 2021). In this context, there is a need to implement strategies to improve milk productivity, such as the use of recombinant bovine somatotropin (rbST), which has significant effects on increasing milk production in cows, as it is capable of acting on nutrient partitioning, improving the efficiency of milk synthesis (WORKU 2023). This biotechnology involves coordinating the metabolism of various organs and tissues in the body, as well as the metabolism of all classes of nutrients (carbohydrates, lipids, proteins, and minerals). These adjustments are of great importance, especially during the initial period of use when milk production increases but food intake does not (BAUMAN 1992).

The administration of rbST has proven to be important for dairy farmers, as it directly impacts the profitability of the system (MORAIS et al. 2017), a fact verified by TAUER (2016) when assessing the financial impact of the use of this drug on dairy farms located in New York (USA) from 1994 to 2013, identifying savings of 5.5% per kilogram of milk produced.

The response pattern to its use is related to a gradual increase in milk production a few days after application, with the maximum response being achieved during the first week. After the effect of rbST ends, milk production gradually returns to the levels seen before the treatment began. If treatment is continuous, the increase in milk production is sustained (BAUMAN et al. 1985). The effect of rbST on the lactation curve can result in higher productivity during the cow's lifetime, a greater number of days in lactation, fewer dry days, higher milk production in its lifetime, and greater persistence in milk production (HERRERA et al. 2009).

Its ability to improve milk production is mainly due to its action on the distribution of absorbed nutrients in favor of the mammary gland, which involves both the direct effects of the hormone on tissues, increasing the expression of IGF-1 in breast tissue, the proliferation and survival of mammary epithelial cells, and the rate of milk synthesis;

as well as metabolic effects that include increased basal metabolic rate, blood flow, lipolysis, gluconeogenesis, blood levels of IGF-1, and 1,25-dihydroxycholecalciferol. All these effects combine and help maintain the mammary epithelial cell population, as well as constant milk production by the animal (PAL et al. 2019).

Research indicates that recombinant bovine somatotropin increases milk production and lactation persistence in cows without negatively affecting the lipid profile and liver function (SIGNOR et al. 2017). It alters milk composition, causing a decrease in fat and an increase in protein content (MORAIS et al. 2017), in addition to interfering with reproduction by increasing the number of large follicles and the percentage of viable oocytes (RIBEIRO et al. 2020).

According to GÓMEZ et al. (2022), in Latin America, there are two commercial rbST somatotropin products in use, similar in their rbST supply but different in their vehicle component: sesame oil and zinc (ZSO-rbST) or lecithin and vitamin E (VEL-rbST). However, they report that there is limited information from studies in tropical areas evaluating the effect of different commercial somatotropin formulations on milk production.

Thus, this study aims to investigate the effect of administering two commercial formulations based on recombinant bovine somatotropin (rbST) on the performance of dairy cows.

MATERIALS AND METHODS

The procedures used in this experiment were approved by the Animal Experimentation Ethics Committee of the Federal Rural University of Amazonia, protocol CEUA No. 1081200720 (ID 000189).

The research was conducted on a farm located in the municipality of Paragominas, in the Southeast Mesoregion of Pará. The climate of the region where the property is located is characterized as hot and humid, with an average annual temperature of 26°C and average relative humidity of 81%. The rainy season runs from December to May, and the dry season from June to November, falling under the Awi climate type according to the Köppen classification, with an average annual rainfall of 1742.9 mm (BASTOS et al. 2005).

The experiment used 54 Girolando breed cows, multiparous, clinically healthy, with normal parturition, with an average body condition score of three (scale of 1 to 5) and an average of 109 days in lactation (DIL). The animals were raised in a feedlot production system and distributed into three treatments (two commercial rbST formulations and a control). Initial milk production and calving order were similar in all groups.

The first group (G1) consisted of 17 animals that received 500 mg of Sometribove zinc (1.4 ml of Lactotropin® Elanco, USA) every 14 days, subcutaneously, in the ischio-rectal fossa, alternating between the left and right sides with each application. The second group (G2) consisted of 19 animals that received 500 mg of recombinant bovine somatotropin, whose vehicle is Vitamin E (Acetate) and Lecithin (2 ml of Boostin® MSD Animal Health) every 14 days, subcutaneously in the ischio-rectal fossa, alternating between the left and right sides with each application. The third group (G3) consisted of 18 animals that did not receive rbST (control).

The animals were fed a diet consisting of corn silage and balanced feed in accordance with farm management practices. All cows underwent milk production measurements every ten days, from 109 to 172 DIL.

The first milk inspection was carried out at the 109th DIL. Milk production checks were performed every fifteen days with total exhaustion 12 hours prior, up to the 172nd DIL. The cows were milked mechanically twice a day with an average interval of 12 hours between milkings.

In order to assess the economic feasibility of using recombinant bovine somatotropin in female cattle based on the results of the experiment, a financial analysis was performed using the following indicators:

• Daily cost of applying the product, obtained by dividing the price of the dose by 14 days

• Estimated increase in milk production, in kg day^{-1}

• The price of milk, in R$ day^{-1}

• Result (profit or loss) = Gross revenue - total cost

Descriptive statistics for the data, represented by arithmetic means and standard errors of the mean (SEM) for each treatment, were obtained using the Means procedure of SAS version 9.3 (SAS/STAT, SAS Institute Inc., Cary, NC). Milk production was evaluated as a repeated measure over time, referring to the moments of data collection (time) according to each treatment (Boostin, Lactotropin, or Control), as well as the Treatment*Time interaction, using the Repeated command generated by the Mixed procedure of SAS. The variable “days in lactation” (DIL) was included in the statistical model as a covariate. The SAS LSMeans mean test was used to compare treatments, using the pdiff ilink lines command of the SAS Glimmix procedure. The graph was created using Sigmaplot version 12.0 (Systat Software GmbH, Erkrath, Germany). A statistical difference was considered when $P \leq 0.05$.

RESULTS AND DISCUSSION

Milk production, according to the number of days in lactation (DIL), can be seen in Table 1. It can be observed that there was no difference in milk production between the two formulations throughout the experiment. However, compared to the Control, there was a difference in the periods of 130 and 172 DIL.

According to BALDI (1999), the response to this hormone varies considerably depending on the species, treatment regimen, stage of lactation, and animal nutrition. Thus, the lack of significant increase in milk production in cows at certain times during this experiment may be associated with factors such as the period of rbST application, where a study by FONTES JÚNIOR et al. (1997) comparing the influence of the stage of lactation on the effect of recombinant bovine somatotropin in cows with a genetic degree of ½ *Bos taurus* X ½ *Bos indicus* showed that the application of this drug during the period from 56 to 100 days of lactation resulted in an increase in milk production, but did not significantly influence the lactation stage corresponding to 101 to 194 days.

Table 1. Milk production (L) of dairy cows on different days of lactation, according to the treatment received (Boostin, Lactotropin, or Control). Paragominas. Pará.

	Boostin			Lactotropin			Control		
	Average	SEM[1]		Average	SEM[1]		Average	SEM[1]	
Number of animals	19			17			18		
Average days in milk (DIL)									
109	16.57	0.89	a	15.17	0.82	a	15.20	0.94	a
119	19.57	0.95	a	18.89	1.54	a	16.83	1.16	a
130	18.86	1.32	a	18.19	1.23	ab	13.00	0.83	b
140	15.23	1.27	a	18.35	1.33	a	14.30	0.98	a
151	15.87	1.28	a	17.91	1.32	a	13.77	0.92	a
160	20.07	1.47	a	17.62	1.65	a	14.26	1.01	a
172	21.19	1.37	a	17.46	1.03	ab	13.09	0.98	b

Standard error of the mean. Averages followed by different letters differ from each other (P<0.05).

The number of applications may also have influenced the response to recombinant bovine somatotropin (Figure 1), a fact supported by the study by OLIVEIRA NETO et al. (2001) in crossbred cows (*Bos taurus* x *Bos indicus*), since during the first application, the milk production of the treated animals (12.6 kg day-1) did not differ from that of the control animals (11.3 kg day-1), and after the fifth application of rbST, the difference in milk production between treated and untreated animals was greater than that obtained after the second and third applications.

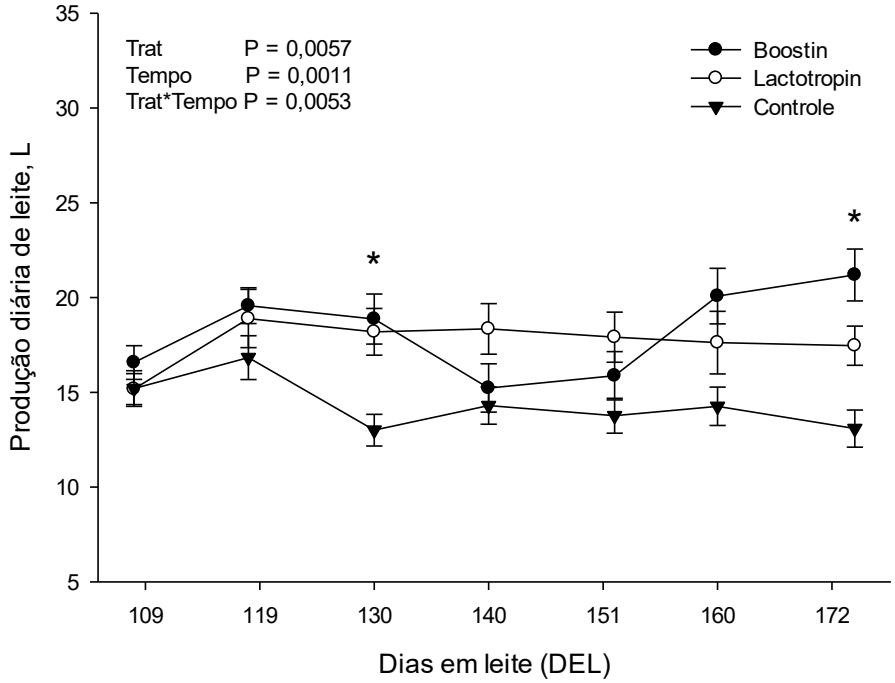

Figure 1. Milk production (L) of dairy cows on different days of lactation, treated with two types of recombinant bovine somatotropin (rbST) or not (Control). Paragominas. Pará.

When comparing the final average milk production per animal between treatments, there was no statistical difference between cows that received 500 mg of Sometribove zinc (1.4 ml of Lactotropin® Elanco, USA) and those in the Boostin® group (MSD Animal Health), but both showed superior results compared to the control (Table 2).

Table 2. Average daily milk production (L) per cow treated with two types of recombinant bovine somatotropin (rbST) or not (Control). Paragominas. Pará, 2019.

Treatment	Comments	Average production Milk (L)[1]	Standard error	Minimum (L)[2]	Maximum (L)[3]
Boostin	133	18.10 a	0.48	7.56	32.56
Lactotropin	119	17.65 a	0.49	7.55	31.78
Control	126	14.36 b	0.38	6.98	27.53

[1]Average daily milk production (L) per cow. [2] Minimum average daily milk production (L) per cow. [3] Maximum average daily milk production (L) per cow. [ab] Averages followed by different letters differ from each other (P<0.05).

These results are similar to those obtained by GOMEZ et al. (2022), who compared the prolonged effect between the two commercial rbST formulas in Peruvian Holstein cows, with the first application when the animals were 30 to 90 days in lactation (DIL), and also found no statistical difference in milk production. However, they differ from the study conducted by MORAIS et al. (2017) with Dutch cows, with application beginning 57 to 70 days after calving, where during the treatment period, animals treated with rbST also had an increase in average milk production compared to the controls. However, the zinc sesame oil-based formula (ZSO-rbST; Lactotropin, Elanco Animal Health, Greenfield, IN) proved to be more efficient than the vitamin E lecithin-based somatotropin (VEL-rbST; Boostin-S, LG Life Sciences, Seoul, South Korea).

Contrary to these data from MORAIS et al. (2017) and the present study, ARAÚJO et al. (2024) reported better milk production for Dutch cows that received Boostin compared to those treated with Lactotropin. One explanation for this variation may be nutritional factors. Where results from RANGEL et al. (2008) show that nutrition is crucial for rbST performance, enabling greater efficiency when cows ingest larger amounts of dry matter, compensating for the volume of milk produced, and having the opportunity to replenish their energy reserves used in lactation.

The analyses showed that there was no significant difference between the formulations, but when comparing the final average milk production per animal between the treatments, it was found that the animals that underwent the rbST protocol had an increase in milk production compared to the control group. According to CARVALHO (2001), the administration of formulations is viable when the results express an average of 2.65 liters/cow/day. This margin of increase was observed in the results obtained in the experiment compared to the control. However, since there is no difference between the formulations, the most suitable one for the system would be the one with the best market price.

The average increase in production with Boostin compared to the control was 3.74 L/cow/day, while with Lactotropin it was 3.29 L/cow/day. Considering the values of each dose, R$18.50 and R$33.00 respectively, and the sale price of a liter of milk produced is R$2.05. We can see from the results obtained that Boostin provides a profit margin of R$6.35/cow/day for every R$1.32 invested. Lactotropin, on the other hand, requires an investment of R$2.36, generating a profit margin of R$4.39/cow/day (Table 3).

Table 3. Economic evaluation in relation to the increase in milk production through the administration of two rbST and control formulations.

Treatment	Average production/L/day	Average increase/L/day	Investment/day/R$	Sale value/R$	Profit/R$
Boostin	18.10	3.74	1.32	7.67	6.35
Lactotropin	17.65	3.29	2.36	6.74	4.39
Control	14.36	0.00	0.00	0.00	0.00

Profitability in relation to production costs is entirely influenced by the market price of milk. CARVALHO (2001) found in his studies that even with production costs increasing due to the higher amount of dry matter in the diet provided, the use of rbST still generates returns for producers. In the present study, the profit margin on the use of the formulations is satisfactory, but it is worth noting that the increase in diet in relation to cost was not considered.

CONCLUSION

The two formulations of recombinant bovine somatotropin administered to dairy cows did not show significant differences between them. Only when compared to the control group was it possible to observe an increase in production at two points in time. The fact that the formulations were administered to cows at 109 days of lactation, which is considered advanced, is the factor most likely to have influenced the results of the applications. Considering that there was no significant difference between the formulations, but taking into account the increase in milk production, the most viable option to use will be Boostin, which has a lower commercial value, generating a higher profit margin. In terms of control, the increase in milk production justifies the use of rbST in dairy cows.

NOTES

AUTHORS' CONTRIBUTIONS

Conceptualization, methodology, and formal analysis, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, Yuri Silva Oliveira, Fabricio Teixeira Souza, and Bruno Moura Monteiro; software and validation: Waldjânio de Oliveira Melo and Bruno Moura Monteiro; research, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, Yuri Silva Oliveira, Fabricio Teixeira Souza, and Bruno Moura Monteiro; resources and data curation, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, Yuri Silva Oliveira, Fabricio Teixeira Souza, and Bruno Moura Monteiro; writing - preparation of the original draft, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, and Bruno Moura Monteiro; writing - revision and editing, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, and Bruno Moura Monteiro; visualization, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, Yuri Silva Oliveira, Fabricio Teixeira Souza, and Bruno Moura Monteiro; supervision, Waldjânio de Oliveira Melo and Bruno Moura Monteiro; project management, Waldjânio de Oliveira Melo and Bruno Moura Monteiro; funding, Waldjânio de Oliveira Melo, Lennon Higor Cardoso de Souza, Yuri Silva Oliveira, and Fabricio Teixeira Souza. All authors have read and agreed to the published version of the manuscript.

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STATEMENT BY THE INSTITUTIONAL REVIEW BOARD
The procedures used in this experiment were approved by the Animal Experimentation Ethics Committee of the Federal Rural University of Amazonia, protocol CEUA No. 1081200720 (ID 000189).

INFORMED CONSENT STATEMENT
Not applicable because this study did not involve humans.

DATA AVAILABILITY STATEMENT
The datasets generated and analyzed during this study are available from the corresponding author upon request.

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CONFLICTS OF INTEREST
The authors declare that there is no conflict of interest.

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