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Effect of two recombinant bovine somatotropin formulations on feeding behavior and metabolism of Holstein cows

Efeito de duas formulações de somatotropina bovina recombinante sobre o comportamento alimentar e metabolismo de vacas da raça Holandesa

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Highlights

Cows from the rbST-Fast group produce more milk;
The rbST-Fast group tends to have higher dry matter consumption;
Consumption was measured using feeding devices which allow individual measurements;
rbST-Fast has higher levels of NEFA without increase in BHB levels.

Abstract

This study evaluated the effect of two commercial forms of recombinant bovine somatotropin (rbST; Later® and Fast®; 500 mg) on feed variability, feeding behavior, zootechnical parameters, and milk production of Holstein cows after peak production. Eighteen cows were randomly divided into two groups and treated with injectable of rbST every 14 days for 70 days. Blood samples were collected on day 1, 4, and 7 of each cycle, to assess circulating levels of non-esterified fatty acids (NEFA). Weight and body condition score (BCS) assessments were performed. Milk yields were measured daily using the DelPro™ software (DeLaval®). Feed consumption and feeding behavior was obtained daily using automatic individual feeders (Intergado®). No difference was observed in dry matter intake (DMI) between groups (P=0.07), and no impact was noted on dietary variability (P=0.64). In addition, animals treated with rbST-Fast exhibited more frequent visits to feeders, longer time in consumption, and higher relative DMI (per percentage of

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live weight) (P<0.01). Animals in the rbST-Fast group produced more milk than those in the rbST-Later group (P=0.03). Furthermore, the weight of the cows was significantly different (P=0.05) between groups. The weight of the rbST-Fast animals was smaller and varied more than thot of the rbST-Later animals (P <0.01). Nonetheless, no difference was noted in BCS (P=0.30) between the groups. The animals in the rbST-Fast group had higher concentrations of NEFA than those in the rbST-Later group (P<0.01). In conclusion, behavioral and metabolic shifts that sustained greater milk production in the cows receiving rbST-Fast. Nonetheless, these shifts are likely linked to lipomobilization and not dietary variability or consumption, as evidenced by the increase in NEFA and greater weight loss in that group.
Key words: Growth hormone. Precision livestock. Variability in food consumption.

Resumo

Este estudo avaliou o efeito de duas formas comerciais de somatotropina bovina recombinante (rbST; Later® e Fast®; 500 mg) na variabilidade alimentar, comportamento alimentar, parâmetros zootécnicos e produção de leite de vacas holandesas após o pico de produção. Dezoito vacas foram divididas aleatoriamente em dois grupos e tratadas com rbST injetável a cada 14 dias durante 70 dias. Amostras de sangue foram coletadas nos dias 1, 4 e 7 de cada ciclo, para avaliar os níveis circulantes de ácidos graxos não esterificados (AGNE). Foram realizadas avaliações de peso e escore de condição corporal (ECC). A produção de leite foi medida diariamente utilizando o software DelPro™ (DeLaval®). O consumo de ração e o comportamento alimentar foram obtidos diariamente em comedouros individuais automáticos (Intergado®). Não foi observada diferença no consumo de matéria seca (CMS) entre os grupos (P=0,07) e não foi observado impacto na variabilidade da dieta (P=0,64). Além disso, os animais tratados com rbST-Fast exibiram visitas mais frequentes aos comedouros, maior tempo de consumo e maior CMS relativo (por porcentagem do peso vivo) (P<0,01). Os animais do grupo rbST-Fast produziram mais leite do que os do grupo rbST-Later (P=0,03). Além disso, o peso das vacas foi significativamente diferente (P=0,05) entre os grupos. O peso dos animais rbST-Fast foi menor e variou mais que o dos animais rbST-Later (P<0,01). No entanto, nenhuma diferença foi observada no ECC (P = 0,30) entre os grupos. Os animais do grupo rbST-Fast apresentaram maiores concentrações de NEFA do que os do grupo rbST-Later (P<0,01). Concluindo, foram observadas mudanças comportamentais e metabólicas que sustentaram maior produção de leite nas vacas que receberam rbST-Fast. No entanto, estas mudanças estão provavelmente ligadas à lipomobilização e não à variabilidade ou consumo dietético, como evidenciado pelo aumento de AGNE e maior perda de peso nesse grupo.
Palavras-chave: Hormônio do crescimento. Pecuária de precisão. Variabilidade no consumo alimentar.

Recombinant bovine somatotropin (rbST) is used to increase milk production and prolong lactation in dairy cows (Worku. 2023). This product stimulates dry matter intake (DMI) to sustain an increase in t milk production (Dohoo et al., 2003; Paula & Silva, 2011). Therefore, feed intake may vary according to milk production (Soliman & El-Barody, 2014).

The variability of food consumption may also be related the rbST release mechanism. Therefore, DMI varies according to hormone levels and how much they impact production. Variability in consumption is one of the five main forms of interference in feed efficiency, warranting further research to evaluate rbST in livestock systems (Herd et al., 2004).

There are two commercial forms of rbST in Brazil: rbST-Later® (Agener União Saúde Animal, São Paulo, São Paulo) and rbST-Fast® (MSD Saúde Animal, São Paulo, São Paulo). Both products are administered subcutaneously in dairy cows with an interval 14 days between applications. The formulations vary in terms of composition, vehicle, and time of effect on production (Ayres et al., 2016). Moreover, these products have been used in dairy systems with animals close to the peak of lactation. However, there are few studies comparing the effects of the two commercial forms. Particularly, animals with more days in lactation, as well as variations in food consumption and productive effects have not been evaluated.

Therefore, the aim of this study was to evaluate the effect of two commercial forms of rbST (rbST-Later® and rbST-Fast®; 500 mg) on feeding variability, feeding behavior, zootechnical parameters, and milk production by Holstein cows after the peak production period.

The study was conducted on a commercial property in Rio Grande, Rio Grande do Sul. All animal procedures were approved by the Ethics and Animal Experimentation Committee of the Federal University of Pelotas under code 14131. Cows were maintained in a compost barn, receiving feed twice daily in the form of totally mixed ration (TMR) in automatic feeders (Electronic trough AF 1000, Intergado®, Betim, Minas Gerais, Brazil) with ad libitum access to water. Milking was performed twice a day.

Eighteen Holstein cows in the second lactation with 90–210 days in lactation (DEL), average milk production of 36.1 Kg/day, were randomly distributed in completely randomized blocks. Two treatments were administered, rbST-Fast (n=9) or rbST-Later (n=9). Both groups received 500 mg of rbST every 14 days, totaling 5 applications over 70 days. These animals were grouped by average milk production, DEL, and reproductive status 14 days before the beginning of the experiment. The injections were applied subcutaneously in the ischiorectal fossa.

Blood samples were collected on the days 1, 4, and 7 of each cycle. Samples were retrieved by puncture of the coccygeal arteriovenous complex, and circulating levels of non-esterified fatty acids (NEFA) were evaluated. Analyses were performed using commercial kits (Wako NEFA-HR, Wako Chemicals USA ®, Richmond, USA) in an automatic biochemical analyzer (Labmax Plenno, Labtest Diagnóstica SA, MG, Brazil).

Food consumption was evaluated daily for 24 hours using automatic individual feeders (Electronic Trough AF 1000,

Intergado®, Betim, Minas Gerais, Brazil). In addition, the intelligent feeders provided data on the total time the animals remained at the feeder (min/day), consumption time (min/day), number of visits without consumption, and number of visits with consumption. To calculate the variability in consumption, an analysis of variance was performed with the coefficient of variation of each cycle as the dependent variable. Dietary DM content analyses were performed using the Koster® moisture meter (Koster Moisture Tester Inc, Brunswick, USA).

Milk production was measured electronically using the DelPro™ software (DeLaval®, Tumba, Botkyrka, Sweden), with in-person monitoring of the two daily milkings. The cows were milked in the morning and afternoon using a herringbone system.

Weight and body condition score (BCS) were measured weekly. Weight was assessed using a bovine weighing tape measure, positioned posterior to the scapulohumeral joint, to determine the circumference of the thoracic perimeter. The BCS was assigned by a trained evaluator using a 1–5 scale and 0.50 point-increments (Wildman et al., 1982). Importantly, the first cycle was used as a covariate for these variables. Moreover, weight and BCS were not among the selection criteria for the animals in the study.

Data were analyzed using the MIXED procedure for repeated measures in the SAS statistical program (SAS v9.4 Institute Inc., Cary, NC, USA). Groups, treatment, time (days or weeks) and their interaction were considered fixed effects, whereas individual cows within each group were considered random effects. For all dependent variables, 4 covariance structures were assessed (1st order autoregressive [AR(1)]; composite symmetric (CS); unstructured (UN); and Toeplitz (TOEP)). The matrix that best fit the model was selected for each variable. Data normality was evaluated from the distribution of residuals using the univariate procedure of the SAS program. Variables that did not have a normal distribution were transformed into logarithms. Data collected prior to the beginning of the experiment were used as a covariate.

In the present study, cows treated with rbST-Fast produced more milk than those in the rbST-Later group (40.75±0.46 and 39.08±0.46, respectively; P=0.03). This is consistent with the data by St-Pierre et al. (2014), in which the average milk production was higher for cows treated with the same commercial form of rbST. Conversely, de Morais et al. (2017) observed greater milk production in cows treated with rbST-Later.

Animals treated with rbST-Fast had more visits to the feeders (P<0.01) and longer time in consumption (P<0.01). Nonetheless, there was no difference in DMI between groups (P=0.07), and no impact on dietary variability (P=0.64). The weight of the animals differed significantly between groups (P=0.05). Animals in the rbST-Fast group were lighter and their live weight varied more than that of animals in the rbST-Later group (P <0.01). Animals in the rbST-Fast group lost approximately 20 Kg throughout the experimental period but exhibited no change in the BSC (P= 0.30). Furthermore, the animals in the rbST-Fast group had higher concentrations of NEFA than those in the rbST-Later group (P<0.01).

Table 1
Body weight, BCS, body weight and BCS variation, and DMI for rbST-supplemented cows (n=18)

Variable	rbST Fast	rbST Later	SEM	P-value
Average BW[1] (kg)	687,10	704,70	5,1	0,05
Change in BW[1] (kg/day)	-20,67	-5,44	3,02	<0,01
Change in BCS[2] (pt[5]/day)	-0,28	-0,22	0,04	0,30
DMI[3] (kg/day)	25,98	25,02	0,33	0,07
Variability intake	21,46	22,30	1,24	0,64
Meal frequency (number/day)	37,82	33,19	0,79	<0,01
Feeding time (min/day)	159,80	147,83	1,68	<0,01
NEFA(mmol/L)[4]	0,61	0,43	0,03	<0,01

[1]BW=Body weight; [2]BCS=Body Condition Score; [3]DMI=Dry matter intake; [4]NEFA=Non-esterified fatty acids; [5]Pt= points; rbST= recombinant bovine somatotropin.

Increased milk production entails increased feed intake to meet the increased energy demand (Kennedy et al., 2008). In this study, the cows allocated approximately 70% of their energy to milk production (31.12 Mcal/day rbST-Fast vs 28.41 Mcal/day rbST-Later). The cows in the rbST-Fast group produced 1.68 Kg/day more milk per day, visited the feeders more often, and spent more time on consumption. Nonetheless, no difference was noted in food intake between the groups. This result is consistent with that by Binelli et al. (1995), who also observed no changes in feed intake by dairy cows in response to hormone treatment. Nonetheless, that study employed hormone protocols that differed from those used in our study. However, an impact of rbST on consumption has been described previously. In the meta-analysis by Dohoo et al. (2003), an increase of 1.50 Kg was reported in the DMI of animals treated with rbST. Likewise, Paula and Silva (2011) demonstrated a proportional increase in consumption and milk production in Girolando cows.

The increased milk production was enabled by lipomobilization, as suggested by the NEFA concentration and loss of body weight over the experimental period. Furthermore, the energy increment that the animals obtained via lipomobilization was 1.90 Mcal/day for the rbST-Fast group and 1.70 Mcal/day for the rbST-Later group (National Research Council [NRC], 2001). In the study by Binelli et al. (1995), a similar effect of rbST was reported. In that study, the hormonal treatment culminated in a decrease in body fat and an increase in NEFA concentration. According to Bauman et al. (1985), rbST can modify the distribution of nutrients between tissues to increase the productive efficiency of dairy cows acting directly on lipolysis (Feckinghaus, 2009). This occurs since the hormone reduces glucose usage by peripheral tissues (Peel & Bauman, 1987) and increases fatty acids mobilization from adipose tissue to be used as an energy source (Gluckman & Breier, 1989).

Consumption by animals in both groups was similar. This suggest that rbST had no impact on the feeding behavior regardless of the commercial form over five cycles of application. This result is consistent with that by Wynsrig et al. (1991), who found no effect on dietary variability, emphasizing our data. Most studies only evaluate food consumption and not the oscillation in intake and its effect on the duration of lactation in multiparous cows. Therefore, further research is needed to investigate the impact of variations in consumption.

In conclusion, behavioral and metabolic shifts sustained increased milk production in cows receiving rbST-Fast. Nonetheless, they are likely linked to lipomobilization and not dietary variability or consumption, as suggested by the increased NEFA and weight loss.

References

Ayres, H., Nichi, M., & Viechnieski, S. L. (2016). Effect of two different bovine somatotropins on milk yield of Brazilian dairy cows. *Proceedings. World Association for Buiatrics, Budapes,* Hungria.

Bauman, D. E., Eppard, P. J., De Geeter, M. J., & Lanza, G. M. (1985). Responses of high producing dairy cows to long term treatment with pituitary somatotropin and recombinant somatotropin. *Journal of Dairy Science, 68*(6), 1352-1362. doi: 10.3168/jds.S0022-0302(85)80972-3.

Binelli, M., VanderkooL, W. K., Chapin, L. T., Vandhaar, M. J., Turner, J. D., Moseley, W. M., & Tucker, H. A. (1995). Comparison of growth hormone releasing factor and somatotropin: body growth and lactation of primiparous cows. *Journal of Dairy Science, 78*(10), 2129-2139. doi: 10.3168/jds.S0022-0302(95) 76840-0

Dohoo, I. R., Leslie, K., Descôteaux, F. A., Dowling, P., Preston, A., and W. Shewfelt (2003). A meta-analysis review of the effects of recombinant bovine somatotropin 1. Methodology and effects on production. *Canadian Journal of Veterinary Research, 67*(4), 241-251.

Feckinghaus, M. A. (2009). *Influência da aplicação da somatotropina recombinante bovina (rBST) no lipidograma e composição do leite de bubalinos da raça Murrahem lactação.* Dissertação de mestrado, Universidade de São Paulo, São Paulo, SP, Brasil.

Gluckman, P. D., & Breier, B. H. (1989). The regulation of the growth hormone receptors. In R. B. Heaps, C. G. Prosser, and G. E. Lamming (Eds.), *Biotechnology in growth regulation* (pp. 27). Toronto.

Herd, R. M., Oddy, V. W., & Richardson, E. C. (2004). Biological basis for variation in residual feed intake in beef cattle: 1. Review of potential mechanisms. *Australian Journal of Experimental Agriculture, Collingwood, 44*(5), 423-430. doi: org/10.1071/EA02220

Kennedy, E., O'donovan, M., Delaby, L., & O'mara, F. P. (2008). Effect of herbage allowance and concentrate supplementation on dry matter intake, milk production and energy balance of early lactating dairy cows. *Livestock Science, 117*(2-3), 275-286. doi: 10.10 16/j.livsci.2007.12.025

Morais, J. P. G. de, Cruz, A. P. S., Veronese, L. P., Del Valle, T. A., & Aramini, J. (2017). Lactation performance of Holstein cows treated with 2 formulations of recombinant bovine somatotropin in a large commercial dairy herd in Brazil. *Journal of Dairy Science, 100*(7), 5945-5956. doi: 10.3168/jds.2016-11 965

National Research Council (2001). *Nutrient requirements of dairy cattle* (7nd rev. ed.). NRC.

Paula, K.S., Silva, D.A. (2011). Somatotropin: Aspects related to its application in dairy cows. *Acta Biomedica Brasiliensia, 2*(8-11), 8-11. doi: 10.18571/acbm.003

Peel, C. J., & Bauman, D. E. (1987). Somatotropin and lactation. *Journal of Dairy Science, 80*(2), 1085-1091. doi: 10.3168/jds.S0022-0302(87)80030-9

Soliman, E. B., & El-Barody, M. A. A. (2014). Physiological responses of dairy animals to recombinant bovine somatotropin: a review. *Journal of Cell and Animal Biology, 8*(1), 1-14. doi: 10.5897/JCAB12.043

St-Pierre, N. R., Milliken, G. A., Bauman, D. E., Collier, R. J., Hogan, J. S., Shearer, J. K., Smith, K.L., Thatcher, W.W (2014). Meta-analysis of the effects of sometribove zinc suspension on the production and health of lactating dairy cows. *Journal of the American Veterinary Medical Association, 245*(5), 550-564. doi: 10.2460/javma.245.5.550

Wildman, E. E., Jones, G. M., Wagner, P. E., Boman, R. L., Troutt, H. F., & Lesch, T. N. (1982). A dairy cow body condition scoring system and its relationship to selected production characteristics. *Journal of Dairy Science, 65* (3), 495-501. doi: 10.3168/jds.S0022-0302(82)82223-6

Wynsrig, M. D., Arambel, M. J., Kent, B. A., & Walters, J. L. (1991). Effect of sometribove on rumen fermentation, rate of passage, digestibility, and milk production responses in dairy cows. *Journal of Dairy Science, 74*(10), 3518. doi: 10.3168/jds.S0022-0302(91)78543-3

Worku, H. A. (2023). A role of exogenous bovine somatotropin on lactation and nutrient mobilization in dairy animals. *Global Journal of Animal Scientific Research, 11*(1), 130-145. doi: 0000-0003-0471-0176