TÜBİTAK

Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Short Communication

Turk J Vet Anim Sci
(2016) 40: 671-674
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doi:10.3906/vet-1510-90

Effects of combining recombinant bovine growth hormone and anabolic implants on growth performance and dietary energetics of Holstein bull calves fed finishing diets

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Received: 31.10.2015 • **Accepted/Published Online:** 28.03.2016 • **Final Version:** 02.11.2016

Abstract: Twenty-one Holstein bull calves (368 ± 5.2 kg) were used in order to evaluate the effects of combining recombinant bovine growth hormone (bST) and anabolic implants on growth performance and dietary energetics. Steers were assigned (7 repetitions/treatment) to individual pens (16 m2) equipped with automatic waterers and 1.2 m fence-line feed bunks. The experiment lasted 56 days. Treatments were: 1) no bST, no implant; 2) implant; and 3) bST + implant. Compared to implanted cattle, the combination of exogenous bovine somatotropin and anabolic implants did not enhance growth performance or observed dietary energy. Compared to nonimplanted cattle, anabolic implants increased dry matter intake (DMI, 8.3%), average daily gain (ADG, 18.5%), gain efficiency (ADG:DMI; 7.9%), dietary net energy (6%), and apparent energy retention per unit of DMI (7%). Implantation reduced the estimated maintenance coefficients of intact Holstein calves by around 17%. The combinations of exogenous bovine somatotropin and anabolic implants did not enhance the growth performance or dietary energy of intact Holstein cattle fed a high-energy finishing diet.

Key words: Growth promoters, Holstein calves, feedlot, performance, dietary energy

Growth-finishing programs for Holstein calves in feedlots have become popular recently in Northwest Mexico. Holstein steers respond with greater gains to high-grain diets than beef steers and are more tolerant to heat stress (1); however, Holsteins require 10% to 12% more energy for maintenance than beef breeds, and they have less muscling than beef breeds (2). In order to increase energy efficiency for growth and muscle development, the use of growth promoters (as steroid implants) is a feasible alternative. Many studies have shown that Holstein cattle have better performance responses when they are implanted at heavier weights (approximately 325 kg live weight) (3). In the same way, the administration of exogenous recombinant somatotropin (recombinant bovine growth hormone, bST) is one biotechnology strategy that increases production (meat or milk) per unit of feed consumed (4,5), but bST promotes protein accretion through different mechanisms than the steroid implants (6,7). A positive response of the effect of combining exogenous bST and implants in feedlot steers has been reported previously (8). Those researchers concluded that the anabolic effects of implants and bST are additive and possibly independent in feedlot steers; however, there is no information available on the comparative effectiveness of both additives in intact cattle. Since, at present, the finishing of intact cattle (bulls) is a widespread system in North Mexico, the objective of this experiment was to determine the effect of combining recombinant bST and anabolic implants on the growth performance and dietary energetics of Holstein bull calves fed a finishing diets. With this aim, 21 Holstein bull calves (initial weight at the start of the experiment: 368 ± 5.2 kg) were individually assigned (7 repetitions/treatment) to pens of 16 m^2 with automatic waterers and 1.2 m fence-line feed bunks. The cattle were processed and adapted to the basal diet and facilities 3 weeks before the start of the experiment. The processing consisted of vaccination against bovine rhinotracheitis and parainfluenza 3 (TSV-27, SmithKline Beecham, West Chester, PA, USA), clostridials (Fortress 7, Pfizer Animal Health, New York, NY, USA), and *Pasteurella haemolytica* (One Shot, Pfizer Animal Health). The cattle were treated against parasites (Ultramectin, RXV Products, Kansas City, MO, USA) and were injected with 1×10^6 IU vitamin A (Vita-Jec A&D "500", RXV Products). Cattle were weighed (electronic

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scale; Fairbanks Scales, Kansas City, MO, USA) individually before the morning meal at the beginning and at the end of the experiment. The experiment lasted 56 days. Treatments were: 1) no bST, no implant (control); 2) implant (IMPL); and 3) bST + implant (bST+IMPL). Cattle assigned to the IMPL treatment received a combination of 120 mg of trenbolone acetate and 24 mg estradiol (Revalor-S, Merck Animal Health, Millsboro, DE, USA) on one occasion at the beginning of the experiment. Implants were inserted between the skin and the cartilage at the back of the middle third of the ear. Cattle assigned to the bST+IMPL treatment received the implant (once in the same place) plus a dose of 500 mg of bST (Lab Monsanto, St. Louis, MO, USA). The dose of bST was applied subcutaneously in the caudal fold, at baseline, and every 14 days during the duration of the experiment. The control group received, in the same place and at the same frequency (ear and caudal fold), a placebo that consisted of 5 mL of distilled water. Cattle were fed ad libitum with a finishing diet formulated as follows (dry matter basis): 72% steam-flaked maize, 5% cottonseed meal, 5% alfalfa hay, 8% wheat straw, 7% molasses cane, 2% tallow, 1% urea, 0.5% mineral premix, and 1.5% limestone. The calculated composition of the basal diet on a dry matter basis (2) was as follows: crude protein, 135 g/kg; maintenance energy, 2.03 Mcal/kg; neutral detergent fiber, 160 g/kg; calcium, 82 g/kg, and phosphorus, 31 g/kg. In order to determine the feed intake on a daily basis, the steers were fed twice daily at 0800 and 1400 hours. The feed bunks were revised 10 min before the morning feed was offered and refusals were collected and weighed. To minimize feed refusal, adjustments of daily feed delivery were provided at the afternoon feeding. The feed and refusal samples were collected daily for dry matter analysis, which involved oven-drying the samples at 105 °C until no further weight loss occurred (method 930.15; AOAC) (9). The estimations of performance, expected dry matter intake (DMI), and dietary energetic were calculated based on shrunk body weight (SBW, BW × 0.96 of full weight) (2). Average daily gain (ADG) was estimated as follows: (initial SBW – final SBW) / 56. Feed efficiency was calculated as ADG / DMI. The estimation of expected DMI was performed using the National Research Council (10) equation as follows:

Expected DMI, kg/day = $(0.084W^{0.75}/ 2.13) + (ADG^{1.097} \times 0.0557W^{0.75} / 1.45)$,

where numerators represent the energy required for maintenance and energy for gain and denominator values correspond to the NE_m and NE_g concentration in basal diet. The observed dietary NE was estimated by means of the quadratic formula proposed by Zinn and Shen (11). The experiment was conducted at the feedlot experimental unit of the Institute of Veterinary Research, Autonomous University of Baja California, Mexico, in the Mexicali Valley, northwestern Mexico (32°40′7″N, 115°28′6″W, about 10 m above sea level, and under Sonoran desert conditions (*BWh* classification according to Köppenclimate classification)). All animal management procedures were conducted within the guidelines of locally approved techniques for animal use and care. The experiment was analyzed using the MIXED procedure of SAS (12) for a randomized complete design. Effects of treatments were tested using orthogonal contrasts. $P \leq 0.05$ was considered significant. Treatment effects on growth performance of Holstein bull calves are presented in the Table. Compared with nonimplanted controls, implanting increased ($P < 0.01$) the overall day 56 DMI (8.3%), ADG (18.5%), gain efficiency (ADG:DMI, 7.9%), dietary NE_m and NE_g (5.6% and 6.4%, respectively), and apparent energy retention per unit of DMI (7%). These results are consistent with previous studies involving calf-fed Holstein steers, wherein implanting improved ADG by 12% to 18% and gain efficiency by 7% to 12% (13,14). Zinn (15) proposed the following equation as an alternative approach for expressing the effect of additives on changes in animal maintenance energetics requirements: $MQ = [NE_m \times (DMI - (EG/NE_g)) / SBW^{0.75}]$, where NE_m and NE_g correspond to the observed dietary NE of controls (2.05 and 1.38 Mcal/kg, respectively; Table), $EG = ADG^{1.097} \times 0.0557W^{0.75}$, and SBW is the average SBW. Accordingly, the implant reduced the maintenance coefficient by 17%. Alternatively, the improved apparent dietary NE for implanted steers may be a reflection of the nonnutritional action of implants on composition of gain, enhancing net protein retention, and, hence, leaner-than-expected tissue growth for the specified live weight and rate of gain (16). Contrary to the findings of Preston et al. (8), the application of bST in implanted intact cattle did not show an additive effect on weight gain, DM intake, or feed efficiency. The use of exogenous bST has been shown to improve the growth performance of cattle when compared with the untreated group (17), but with no advantage over the implanted animals (18). The anabolic implants increase plasma concentrations of somatotropin and IGF-1, while exogenous bST mainly increases the plasma concentration of IGF-1 (6,7). Therefore, the lack of additive effect of bST in implanted cattle may have been due to the fact that, in intact cattle, the effects of expression of bST on increasing circulating IGF-1 were masked (19). To our knowledge,

Table. Treatment effects on growth performance and dietary energetics of Holstein bull calves.

Item	Control[1]	IMPL[2]	BST+IMPL[3]	SEM
Replicates	7	7	7	
Weight, kg				
Initial	365.4	365.3	365.1	3.1
Final	456.4[a]	477.3[b]	473.2[b]	4.5
DM intake, kg/day	10.01[a]	10.92[b]	10.52[b]	0.13
Average daily gain, kg	1.63[a]	2.00[b]	1.93[b]	0.05
Feed for gain	0.162[a]	0.176[b]	0.177[b]	0.003
Diet energy, Mcal/kg				
Maintenance	2.05[a]	2.19[b]	2.20[b]	0.02
Gain	1.38[a]	1.51[b]	1.52[b]	0.02
Observed to expected dietary NE				
Maintenance	1.01[a]	1.07[b]	1.08[b]	0.01
Gain	1.02[a]	1.09[b]	1.10[b]	0.01
Observed to expected DMI	0.99[a]	0.92[b]	0.91[b]	0.01

[a,b] Different letters for the same variable indicate statistical differences ($P \leq 0.05$).
[1] The nonimplanted controls received subcutaneously in the caudal fold at baseline and every 14 days during the duration of the experiment a placebo that consisted of 5 mL of distilled water.
[2] Received a dose of 500 mg of bovine somatotropin (Lab Monsanto, St. Louis, MO, USA) subcutaneously in the caudal fold at baseline and every 14 days during the duration of the experiment and a combination of 120 mg of trenbolone acetate and 24 mg estradiol (Revalor-S, Merck Animal Health, Millsboro, DE, USA) on one occasion at the beginning of the experiment.
[3] Received a combination of 120 mg of trenbolone acetate and 24 mg estradiol (Revalor-S, Merck Animal Health) on one occasion at the beginning of the experiment.

at the moment of writing the present report, there was no information available on the effect of exogenous bST on growth performance and plasma concentration of metabolites in intact cattle.

In conclusion, the combination of bST and anabolic implants did not enhance the growth performance or dietary energy of intact Holstein cattle fed a high-energy finishing diet compared to implanted cattle.

References

1. Duff GC, Casey PM. Feeding Holstein steers to start to finish. In: Hollis LC, Olson KC, editors. Veterinary Clinics of North America. Food Animal Practice. Philadelphia, PA, USA: Elsevier, Mosby Saunders; 2007. pp. 281-287.
2. National Research Council. Nutrient Requirement of Beef Cattle. 7th ed. Washington, DC, USA: National Academy Press; 2000.
3. Beckett JL, Algeo I. Effects of delayed implant protocols on performance, carcass characteristics and meat tenderness in Holstein steers. J Anim Sci 2002; 80 (Suppl. 1): 49.
4. Dohoo IR, Leslie K, DesCôteaux L, Fredeen A, Dowling P, Preston A, Shewfelt W. A meta-analysis review of the effects of recombinant bovine somatotropin: 1. Methodology and effects on production. Can J Vet Res 2003; 67: 241-251.
5. Velayudhan BT, Govoni KE, Hoagland TA, Zinn SA. Growth rate and changes of the somatotropic axis in beef cattle administered exogenous bovine somatotropin beginning at two hundred, two hundred fifty, and three hundred days of age. J Anim Sci 2007; 85: 2866-2872.

6. Etherton TD, Bauman DE. Biology of somatotropin in growth and lactation of domestic animals. Phys Rev 1998; 78: 745-761.

7. Dayton WR, White ME. Mechanism of anabolic steroid action in bovine skeletal muscle. In: Cobb GP, Smith NP, editors. Evaluating Veterinary Pharmaceutical Behavior in the Environment. Washington, DC, USA: ACS Publications; 2013. pp. 1-12.

8. Preston RL, Bartle SJ, Kasser TR, Day JW, Veenhuizen JJ, Baile CA. Comparative effectiveness of somatotropin and anabolic steroids in feedlot steers. J Anim Sci 1995; 73: 1038-1047.

9. AOAC. Official Methods of Analysis. 17th ed. Arlington, VA, USA: Association of Official Analytical Chemists; 2000.

10. National Research Council. Nutrient Requirement of Beef Cattle. 6th ed. Washington, DC, USA: National Academy Press; 1984.

11. Zinn RA, Shen Y. An evaluation of ruminally degradable intake protein and metabolizable amino acid requirements of feedlot calves. J Anim Sci 1998; 76: 1280-1289.

12. Statistical Analysis System. SAS/STAT: User's Guide Release 9.1. Cary, NC, USA: SAS Institute Inc.; 2004.

13. Perry TC, Fox DG, Beerman DH. Effect of an implant of trenbolone acetate and estradiol on growth, feed efficiency and carcass composition of Holstein and beef steers. J Anim Sci 1991; 69: 4696-4702.

14. Zinn RA, Alvarez EG, Montano M, Ramirez JE, Shen Y. Implant strategies for calf-fed Holstein steers. Proc Western Sect Am Soc Anim Sci 1999; 50: 306-309.

15. Zinn RA. Influence of lasalocid and monensin plus tylosin on comparative feeding value of steam-flaked versus dry-rolled corn diets for feedlot cattle. J Anim Sci 1987; 65: 256-266.

16. Reinhardt, C. Growth-promotant implants: managing the tools. In: Hollis LC, Olson KC, editors. Veterinary Clinics of North America. Food Animal Practice. Philadelphia, PA, USA: Elsevier, Mosby Saunders; 2007. pp. 309-319.

17. Rausch MI, Tripp RW, Govoni KE, Zang W, Weber WJ, Crooker BA, Hoagland TA, Zinn SA. The influence of level of feeding on growth and serum insulin-like growth factor I and insulin-like growth factor binding proteins in growing beef cattle supplemented with somatotropin. J Anim Sci 2002; 80: 94-100.

18. Hancock DL, Preston RL. Titration of the recombinant bovine somatotropin dosage that maximizes the anabolic response in feedlot steers. J Anim Sci 1990; 68: 4117-4126.

19. Schoonmaker JP, Loerch SC, Fluharty FL, Turner TB, Moeller SJ, Rossi JE, Dayton WR, Hataway MR, Wulf DM. Effect of accelerated finishing program on performance, carcass characteristics and circulating insulin-like growth factor I concentration of early-weaned bull and steers. J Anim Sci 2002; 80: 900-910.