EFFECT OF RECOMBINANT BOVINE SOMATOTROPIN ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF FINISHING KOREAN NATIVE BULLS

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Summary

This experiment was conducted to investigate the effect of bST administration on gorwth performance and carcass characteristics of finishing Korean native bulls. Fifty four Korean native bulls of about 14 months of age weighing an average 420 kg were assigned to receive no injection of bST, 250 mg of bST s.c. injection every week, or 500 mg bST s.c. injection every 2 weeks(Control, 250ST, 500ST) in a 3 × 3 randomized block design for a period of 20 weeks. Animals administered with bST responded with decreased feed DMI by 8%($p < 0.01$), increased ADG by 12%($p < 0.05$), and increased gain/feed ratio by 20%($p < 0.01$). But there was no significant difference in the growth performance between 250ST and 500ST. Administration of bST increased dressing percentage by 1.8%($p < 0.05$), and tended to increase *longissimus* muscle area and decrease backfat thickness and marbling score.
(**Key Words**: bST, Growth, Carcass, Korean Native Bulls)

Introduction

Administration of exogenous somatotropin to animals improve growth performance and alter carcass composition. Growth rates of cattle, sheep and swine are increased, and carcass composition is shifted toward increased lean accretion and decreased lipid deposition with administration of somatotropin (Pell, 1989).

Generally feed DMI increased by 2 to 6% due to bST injection to calves and heifers (Kirchgessner et al., 1987; Sandles and Peel, 1987). But some papers observed that feed DMI was not affected (Early et al., 1990a; Enright et al., 1990), or decreased by 4 to 17% with administration of bST to steers (Dalke et al., 1992; Moseley et al., 1992). Summary of the published growth trials in heifers and steers treated with bST during growing and finishing phases indicated that these cattle responded with an average improvement of 6 to 15% for ADG and 2 to 23% for gain/feed ratio (Sejrsen et al., 1986; Enright et al., 1990; Dalke et al., 1992).

Alterations in carcasses are consistent in steers, heifers and bulls treated with bST. Bovine somatotropin decreased backfat thickness, marbling scores and quality grade, but increased *longissimus* muscle area (Dalke et al., 1992; Moseley et al., 1992). Some studies observed that dressing percentage increased up to 2.5% with administration of bST to young and light cattle (Sejrsen et al., 1986; Kirchgessner et al., 1987), whereas others observed the reduction of dressing percentage up to 4% due to bST injection to steers (Early et al., 1990b; Moseley et al., 1992).

The present paper reports on the effect of sustained-release recombinant bovine somatotropin (SR-rbST) on the growth performance and carcass characteristics in Korean native bulls.

Materials and Methods

Experimental design and animal management

Fifty four Korean native bulls of about 14 months of age weighing an average 420 kg were assigned to receive either no bST injection, 250 mg of bST s.c. injection every week, or 500 mg of bST s.c. injection every two weeks (Control, 250ST, 500ST) in a 3 × 3 randomized block design for a period of 20 weeks. The daily dose of bST in this experiment represented approximately 85 μg per kg of initial body weight of animals, which is inclusive of the range of doses reported previously for

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Received March 4, 1995

Accepted September 6, 1995

growth trials with beef cattle breeds.

Animals were housed at the experimental farm of Taihan Sugar Co. (Ansung, Korea) in 9 pens. The first day of bST treatment was designed as d 1. Animals from each pen were taken out of the pen, moved through the corrals, injected with respective dose of bST, and returned to respective pens. Each morning the feed bunks were observed and 115% of feed consumed in the previous day was offered daily at 09:00 based on the amount of residual in the feed bunks. All animals were weighed before feeding on d 1-7, d 1-1, d 1 and d 14 after overnignt feed and water restriction. Body weight thereafter was measured every two weeks.

Somatotropin

Bovine somatotropin used in this experiment was manufactured by Lucky Research Park (Daejeon, Korea). Bovine somatotropin was administered as subcutaneous injections for 250ST and 500ST, respectively, at the tail heads.

Feed

Total mixed ration with 80% concentrate mixture, 12% cottonseed hull pellet and 8% compressed rice straw were fed on an ad libitum basis. A concentrate mixture was designed for finishing Korean native bull and manufactured in a 6.4 mm pellet.

Ingredient and chemical composition of concentrate, compressed rice straw and cottonseed hull pellet are shown in table 1. And chemical composition of feeds were analyzed using AOAC (1990) procedure.

Carcass measurements

Six animals averaging 560 kg of body weight per treatment were selected and slaughtered at Seoul Livestock Products Marketing Center of National Livestock Cooperatives Federation. Chilled carcass weight was measured after 24 to 48 h cooling at 1℃ after the head, feet, hide and visceral organs had been removed. Carcass characteristics were determined according to Korean carcass grading system of Korea Animal Improvement Association (1991). *Longissimus* muscle area was measured at the proximal surface between the 13th rib and the first lumbar vertebra. Backfat thickness was measured at 2/3 arc of the *longissimus* muscle toward vertebra. Other carcass traits such as marbling score, lean color, fat color, texture and maturity were measured at the *longissimus* muscle area.

Statistical analysis

Statistical analysis were performed by the method of ANOVA using GLM procedures of SAS (1985) for randomized block design. ANCOVA was used to test for significant relationships among live weight and chilled carcass weight, dressing percentage, *longissimus* muscle area, backfat thickness, and other carcass traits. Effect of bST administration was analyzed by orthogonal contrast.

TABLE 1. INGREDIENT AND CHEMICAL COMPOSITION OF EXPERIMENTAL DIETS (AS-FED BASIS)

Index	Con-centrate	Rice straw	Cotton seed hull
Ingredient composition (%)			
Corn	35.52		
Tapioca	15.00		
Wheat bran	19.20		
Corn gluten feed	15.00		
Soybean meal	3.60		
Molasses	6.00		
Urea	1.00		
Limestone	1.78		
Salt	0.50		
Sodium bicarbonate	1.00		
Mineral & vitamin premix[1]	1.40		
Chemical composition			
Moisture (%)	12.12	12.00	10.00
Crude protein (%)	14.00	4.50	3.60
Crude fat (%)	2.62	2.18	1.44
Crude fiber (%)	4.81	28.30	43.20
Crude ash (%)	7.52	15.10	2.70
Calcium (%)	0.80	0.34	0.16
Phosphorus (%)	0.40	0.13	0.08
NE, Mcal[2]	1.70	0.56	0.63

[1] Minerals and vitamins were added as follows; Vit A: 6,000 IU, Vit D_3: 1,200 IU, K: 0.08%, S: 0.05%, Fe: 30 ppm, Zn: 50 ppm, Mn: 40 ppm, Cu; 10 ppm, Co: 0.5 ppm, I: 0.53 ppm, Se: 0.13 ppm, Mg: 0.03%.

[2] Calculated from tabular values for each ingredient in CVB (1992): Ne, Mcal = VEVI × 1.65.

Results and Discussion

Feed DMI

Daily feed DMI of 250ST and 500ST decreased by 0.79 and 0.61 kg, respectively, compared with Control ($p < 0.05$), which is 8% decrease for bST treatment groups compared with Control ($p < 0.05$). But there was no significant difference in feed DMI between 250ST and 500ST treatment (table 2).

Steers treated with bST during the finishing phase responded with an average decrease of 7 to 8% in feed

DMI (Wagner et al., 1988; Dalke et al., 1992), which is similar to data obtained in present study. Moseley et al. (1992) and Peters (1986) also observed a decreased feed DMI with a slightly higher magnitude (13 to 17%) with administration of bST to steers. But other papers described that bST did not significantly affect feed DMI (Early et al., 1990a; Enright et al., 1990; Garssen and Oldenbroek, 1992).

The causes of disparity in the response of feed DMI to bST between previous studies and this study are unclear. However, it is difficult to make direct comparisons among studies because of the differences in diet, age of cattle, dosage and source of bST, duration of administration, and experimental protocol used in different studies (Moseley et al., 1992).

The differences in feed DMI between early and late part of experimental period (table 2) may be attributed to the difference in the dose of bST per kg body weight. In this study 500 mg of bST/2 weeks and 250 mg of bST/week were administered throughout experiment. So average daily dose of bST was equivalent to 85 μg per kg of body weight during the first 10 weeks of experiment, and 71 μg per kg of body weight during the last 10 weeks of experiment. Therefore the different dose of bST seemed to be partly related with feed DMI.

TABLE 2. EFFECT OF bST ON THE GROWTH PERFORMANCE OF FINISHING KOREAN NATIVE BULLS

Item	Treatment[1]			SEM	Contrast[2]
	Control	250ST	500ST		
Week 0-10					
Initial BW (kg)	427	419	417	4	-
Final BW (kg)	500	504	500	5	-
Daily DMI (kg)	9.14[a]	8.00[b]	8.22[b]	.08	**
ADG (kg)	1.04[b]	1.22[a]	1.17[ab]	.03	*
Gain/feed ratio	.114[a]	.153[b]	.142[b]	.007	**
Week 10-20					
Initial BW (kg)	500	504	500	5	-
Final BW (kg)	556	562	561	6	-
Daily DMI (kg)	8.94[a]	8.54[b]	8.66[ab]	.07	*
ADG (kg)	0.79	0.82	0.88	.03	-
Gain/feed ratio	.088	.096	.102	.003	-
Week 0-20					
Initial BW (kg)	427	419	417	4	-
Final BW (kg)	556	562	561	6	-
Daily DMI (kg)	9.05[a]	8.26[b]	8.44[b]	.05	**
ADG (kg)	0.92[b]	1.02[a]	1.03[a]	.03	*
Gain/feed ratio	.102[a]	.123[b]	.122[b]	.004	**

[1] Control: No injection; 250ST: 250 mg bST injection every week; 500ST: 500 mg bST injection every 2 weeks.
[2] Control vs 250 and 500ST; GLM and orthogonal contrast: - Not significant, * $p < 0.05$, ** $p < 0.01$.
[ab] Values with different superscripts in a row are significantly different ($p < 0.05$).

ADG

ADG of 250ST and 500ST increased by 0.10 and 0.11 kg, respectively, compared with Control ($p < 0.05$), which is 12% higher than Control ($p < 0.05$). However, there was no significant differences in ADG between 250ST and 500ST treatment (table 2).

Summary of the published growth trials with heifers and steers treated with bST during growing and finishing phases indicated that these cattle responded with a consistent improvement in ADG (Sejrsen et al., 1986; Kirchgessner et al., 1987; Sandles and Peel, 1987; Wagner et al., 1988; Enright et al., 1990; Maltin et al., 1990). The increases in net muscle and (or) whole body growth rates which were induced by administration of exogenous somatotropin could be due to one or a combination of several metabolic factors as follows; an increase or a change in the pattern of nutrient absorption from the gut, an alteration in their subsequent hepatic metabolism resulting in more or different substrates supply to the peripheral tissues, and a change in metabolism by target tissues (Pell, 1989). But Dalke et al. (1992) observed no significant response in ADG when beef steers averaging

377 kg were implanted with daily dose of 15, 30 and 60 μg of bST per kg of body weight s.c. on a weekly basis. Muir et al. (1983) and Rosemberg et al. (1989) also observed no significant response in ADG with administration of somatotropin to lambs. Early et al. (1990a) proposed several factors responsible for the variability in responses to somatotropin administration including source of somatotropin, administration dose of somatotropin, sex and age of animals, duration of somatotropin administration, environmental factors and breeds.

Responses in ADG to bST in the late part of this experiment were relatively low, which may be partly due to lower dose of bST per body weight of animals in this period (table 2). Heird et al. (1988) also observed the similar response of somatotropin in lambs. Dalke et al. (1992) reported the maximal daily effective dose of bST as more than 60 μg per kg of body weight. Fabry (1992) also observed that more than 100 μg bST per kg of body weight were needed for maximum growth performance of finishing bulls.

Gain/feed ratio

Gain/feed ratio of bulls on 250ST and 500ST treatment increased by 0.021 and 0.020, respectively, compared with Control ($p < 0.01$), resulting in an average of 20% improvement in feed efficiency ($p < 0.01$) with no significant difference between 250ST and 500ST treatment (table 2).

An average of 20% improvement in feed efficiency is the results of combination of decreased feed DMI (8%) and increased ADG (12%) with administration of bST. Wagner et al. (1988) also observed an improvement of 18% in gain/feed ratio with administration of somatotropin to steers averaging 375 kg, and the response was attributed to decreased feed intake (8%) and increased ADG (10%). Summary of the published growth trials with heifers and steers treated with bST during growing and finishing phases indicated that cattle responded with a consistent improvement in gain/feed ratio (Sejrsen et al., 1986; Kirchgessner et al., 1987; Sandles and Peel, 1987; Wagner et al., 1988; McShane et al., 1989; Early et al., 1990a; Enright et al., 1990; Dalke et al., 1992; Fabry, 1992).

Several other types of response to bST treatment in gain/feed ratio have been observed. Bovine somatotropin improved gain/feed ratio in growing ruminants by enhancing growth rate without greatly increasing feed consumption or, in some instances, by decreasing feed intake without affecting growth rate (Early et al., 1990a). Improved nutrient absorption and (or) changes in body composition have been attributed to the increased gain/feed ratio (McShane et al., 1989). Dalke et al. (1992) also concluded that bST redirected growth toward lean tissue deposition in carcass components and this partitioning was a probable explanation for the improvement in gain/feed ratio.

Moseley et al. (1992) observed that gain/feed ratio of steers increased by 12.1 and 6.6%, respectively, with injection of 33 and 100 μg of bST per kg of body weight, but decreased by 35.5% with injection of 300 μg of bST per kg of body weight in crossbred beef steers. Other studies indicated no response of gain/feed ratio with administration of somatotropin to lambs (Muir et al., 1983; Rosemberg et al., 1989).

The causes of disparity between previous studies and these data are not clear. Perhaps direct comparison among studies is not relevant because most experiments were carried out in different conditions in terms of source of somatotropin, administration dose and biological potency of somatotropin, frequency and administration route of somatotropin, number, sex, age and type of animals used in experiments, nutrients level, type of diets, and experimental protocol (Enright, 1990).

Carcass characteristics

Dressing percentage increased by 2.6% in 500ST compared with Control ($p < 0.05$). And bST treatment incresed dressing percentage by 1.8% compared with Control ($p < 0.05$). An increase in dressing percentage by bST administration might be due to decreased backfat thickness and increased *longissimus* muscle area as shown in table 3 and 4. As a result of these changes marbling score tended to decrease with administration of bST. But bST did not change other carcass traits such as lean color, fat color, texture or maturity (table 3).

Some studies observed that dressing percentage increased up to 2.5% with administration of bST to young and light cattle (Sejrsen et al., 1986; Kirchgessner et al., 1987). Sandles and Peel (1987) also observed an increse of 9% in carcass weight with administration of bST to heifers. But this study employed a very high dose of bST and animals were slaughtered at a light weight (approximately 165 kg).

Enright et al. (1990) observed that administration of pituitary derived bST to steers had no effect on dressing percentage, and this was consistent in lambs (Wise et al., 1988). Moseley et al. (1992) observed that dressing percentage was reduced by 0.6 to 1.3% in steers receiving daily dose of 8.25 to 100 μg of bST per kg of body weight and by up to 4% in those receiving 300 μg of bST per kg of body weight daily. A reduction in carcass

TABLE 3. EFFECT OF bST ON THE CARCASS CHARACTERISTICS OF FINISHING KOREAN NATIVE BULLS

Item	Treatment[1]			SEM	Contrast[2+]
	Control	250ST	500ST		
Live wt (kg)	567	578	563	3	–
Chilled carcass wt (kg)	323	335	336	3	–
Dressing percentage (%)	57.0[b]	58.0[b]	59.6[a]	0.4	*
Backfat thickness (cm)	0.9	0.7	0.6	0.1	–
Longissimus muscle area (cm^2)	77.0	82.0	80.0	1.6	–
Meat production index[3]	75.9	76.5	75.9	0.3	–
Marbling score[4]	3.3	2.7	3.0	0.4	–
Lean color[5]	3.3	4.0	3.7	0.2	–
Fat color[6]	3.3	3.0	3.3	0.1	
Texture[7]	1.5	1.7	1.7	0.1	
Maturity[8]	1.0	1.0	1.0	0.0	

[1] Control: No injection; 250ST: 250 mg bST injection every week; 500ST: 500 mg bST injection every 2 weeks.
[2+] Control vs 250 and 500ST; GLM and orthogonal contrast: - Not significant, $^*p < 0.05$, $^{**}p < 0.01$.
[3] MPI = 74.80 − (2.001 × backfat thickness, cm) + (0.075 × *longissimus* muscle area, cm^2) − (0.014 × carcass weight, kg).
[4] 1: Poor; 5: Excellent.
[5] 1: Bright red; 7: Dark red.
[6] 1: Bright yellow; 7: Dark yellow.
[7] 1: Excellent; 4: Poor.
[8] 1: Animals less than 3 years old; 3: Animals more than 5 years old.
[ab] Values with different superscripts in a row are significantly different($p < 0.05$).

TABLE 4. EFFECT OF bST ON THE BACKFAT THICKNESS OF FINISHING KOREAN NATIVE BULLS AT VARIOUS CARCASS AREAS

Item	Treatment[1]			SEM	Contrast[2]
	Control	250ST	500ST		
	········· cm ·········				
13th rib[3]					
Area 1	0.96	0.72	0.78	0.08	–
Area 2	1.43	1.28	1.16	0.09	–
Area 3	1.22	1.10	0.96	0.10	–
7-8th rib	0.96	0.72	0.80	0.08	–
3-4th lumbar vertebra	1.48	1.25	1.15	0.12	–

[1] Control : No injection; 250ST: 250 mg bST injection every week; 500ST: 500 mg bST injection every 2 weeks.
[2] Control vs 250 and 500ST; GLM and orthogonal contrast: - Not significant, $^*p < 0.05$, $^{**}p < 0.01$.
[3] Area 1: 10 cm inner side from 13th rib; Area 2: 6 to 8 cm inner side from 13th rib; Area 3: 2 to 3 cm inner side from 13th rib.

fat in response to bST was also observed in the same study.

Alteration in carcass has been consistently reported with steers, heifers and bulls treated with bST (Peters, 1986; Sejrsen et al., 1986; Sandles and Peel, 1987). Dalke et al. (1992) observed bST decreased backfat depth, marbling score and quality grade in a linear dose-dependent manner, and the magnitude of decrease was 19.3, 13.7, and 17.1%, respectively, with yield grade being improved by 15.6% at the 160 mg/wk of bST level. Moseley et al. (1992) also observed that an increase of 4 to 15% in *longissimus* muscle area and a reduction of 6 to 57% in backfat thickness with daily injection of bST. They observed the reduction in percentage of carcass receiving the Choice grade in response to daily bST injection, and this reduction was consistent with a reduction in both fat thickness over the rib section and fat within the *longissimus* muscle. But Peters (1986) observed that chronic treatment with somatotropin resulted in a relative reduction of lipid accretion only when animals were fed ad libitum.

Acknowledgement

The authors wish to acknowledge that present study was conducted with a financial support from Lucky Research Park and Animal Resources Research Center, Konkuk University, Korea.

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