Zilpaterol hydrochloride impact on core body temperature, performance, and carcass characteristics in finishing beef steers

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STORY IN BRIEF

Feeding zilpaterol hydrochloride during the final 20 d on feed improved feedlot performance and carcass traits of beef steers. Steers offered zilpaterol reached their maximum daily temperature earlier in the day compared to control, indicating that zilpaterol may have had a cooling effect. This experiment was conducted when environmental temperatures were mild to cold. Therefore, future research should investigate the effects of zilpaterol during the summer.

Key Words: beef steers, beta-adrenergic agonists, body temperature

INTRODUCTION

β-adrenergic agonists (βAA) improve feedlot performance and carcass traits of finishing beef cattle (Moloney et al., 1990; Chikhou et al., 1993). Zilpaterol hydrochloride (ZH) was approved in 2006 for inclusion in feedlot diets for the final 20 to 40 days prior to harvest with a 3-d withdrawal period (FDA, 2006). Zilpaterol hydrochloride has been shown to increase final live BW, ADG, G:F, HCW, dressing percent, and LM area, and to decrease yield grade while having no impact on 12th-rib fat thickness (Montgomery et al., 2009). β-adrenergic agonists generally increase heart rate and respiration rate (Eiler, 2004), which has been demonstrated in cattle (Bruckmaier and Blum, 1992). However, the effect of βAA on core body temperature in feedlot cattle has not been explored. The objective of this experiment was to determine the effect of feeding ZH on core body temperature of finishing steers when fed for 20 days prior to harvest with a 5-d withdrawal period.

MATERIALS AND METHODS

Sixty-eight British and British × *Bos indicus* crossbred steers (mean BW = 770 ± 20 lb) were randomly assigned to one of 12 pens, and pens were randomly assigned to one of two treatments, including 0 (control) or 3.77 mg of ZH included per pound of diet for 20 days at the end of the finishing phase with a 5-d withdrawal period prior to harvest. Treatment diets were fed from d 16 to 35. All other times, all calves received the control diet.

Steers were orally administered a remote temperature monitoring ruminal bolus on d 0 (November 6, 2008), which remained permanently in the reticulum. Individual steer temperature data, on average, was received from the bolus every 11 ± 8 min via fixed transceiver stations, which were specifically designed to receive bolus signals. Additional transceivers relayed bolus data to a fixed transceiver station equipped with a USB serial connection, which logged temperature data in a database on the attached computer. Temperature recording began on d 7, which was the first day that computers and data receivers were fully functional.

Temperature data was observed for each steer, and water drinking events were identified and removed from the data set. Then, individual temperature data was summarized by determining the average and maximum daily temperatures, and the time of maximum daily temperature occurrence. The percentage of steers that reached their maximum daily temperature during each of eight 3-h time intervals was calculated. All temperature data were summarized for each pen, and categorized into one of three time periods including; 1) prior to ZH inclusion, 2) during ZH inclusion, and 3) ZH withdrawal period.

Final live BW were recorded on d 40, and steers were transported 275 miles to a commercial abattoir, where they were harvested the following morning. After a 36-h chill, carcasses were ribbed at the 12th rib, and USDA Quality and Yield Grades and carcass traits were recorded. Carcass traits measured included marbling score, 12th-rib fat thickness, LM area, and percentage of internal fat. Dressing percent was calculated using a 4% shrunk final live BW.

This experiment was conducted as a completely randomized design, with pen as the experimental unit. Animal performance, carcass traits, and temperature data were analyzed using the MIXED procedure of SAS. Categorical data were analyzed using the GLIMMIX procedure of SAS. Fixed effects included treatment for the performance and carcass data, and treatment, period, and treatment × period for the temperature data. Temperature data were analyzed using repeated measures with day as the repeated subject. The random effect for all analyses was pen within treatment. Least squares means were calculated, and when means were different at the $P \leq 0.10$ level, means were separated using the PDIFF statement. Differences are discussed when $P \leq 0.05$, and considered tendencies when $0.05 < P \leq 0.10$.

RESULTS AND DISCUSSION

All performance data are shown in Table 1. There were no treatment differences ($P > 0.18$) in initial BW (mean = 1165 ± 8 lb) or final BW (mean = 1294 ± 10 lb); however, feeding ZH resulted in 0.6 lb/d greater ($P = 0.002$) ADG. Dry matter intake was measured during each period, and across the entire experiment, with no treatment differences ($P > 0.58$) observed. As a result of the greater ADG observed in steers offered ZH, G:F of steers consuming ZH was 21.2%

Table 1. Effect of zilpaterol hydrochloride (ZH) on steer performance and intake[a]

	Treatment			
Item	Control	ZH	SEM	*P*-Value
BW, lb				
Initial	1166.7	1164.2	8.2	0.83
Final	1284.1	1303.5	9.5	0.18
ADG, lb	2.97	3.61	0.11	0.001
DMI, Period 1, lb/d[b]	21.10	21.48	0.48	0.58
DMI, Period 2, lb/d	22.07	21.98	0.36	0.86
DMI, Period 3, lb/d	21.75	21.37	0.49	0.59
DMI, Overall, lb/d	21.65	21.72	0.29	0.87
G:F	0.137	0.166	0.004	0.0005

[a]Values reported are least squares means

[b] Period 1, Prior to ZH inclusion; Period 2, During ZH inclusion; Period 3, ZH withdrawal period

greater ($P = 0.001$) compared with control steers. Montgomery et al. (2009) reported similar results when finishing steers were offered ZH for the final 20 d on feed.

Feeding ZH resulted in 34.6 lb greater ($P = 0.01$) HCW and 5.7% greater ($P = 0.01$) dressing percent (Table 2). Marbling score and 12th-rib fat thickness were not affected ($P \geq 0.36$) by ZH. Zilpaterol inclusion resulted in 2.62 in^2 greater ($P = 0.001$) LM area, and decreased ($P = 0.03$) internal fat by 17.5%. The percentage of steers grading USDA Yield Grades 2, 3, 4, and 5 were not affected ($P \geq 0.23$) by ZH; however, average yield grade decreased ($P = 0.02$) by 10.0% in steers offered ZH. Quality grade was not affected ($P \geq 0.23$) by ZH inclusion. Montgomery et al. (2009) observed a shift in quality grade as a result of ZH, with a greater percentage of ZH steers grading Select compared with control. However, other carcass data results in the present study are in agreement with those of Montgomery et al. (2009).

Table 2. Effect of zilpaterol hydrochloride (ZH) on carcass characteristics of steers[a]

	Treatment			
Item	Control	ZH	SEM	*P*-Value
HCW, lb	813.3	847.9	8.1	0.01
Dressing %	61.67	65.17	0.76	0.01
Marbling score[b]	379.1	379.1	11.7	0.99
12th-rib fat thickness, in	0.72	0.67	0.03	0.36
LM area, in^2	30.73	33.35	0.43	0.001
Internal fat, %	3.03	2.50	0.15	0.03
Condemned livers, %	11.76	5.88	5.53	0.42
Quality grade				
Standard, %	0.00	2.94	2.90	0.98
Select, %	67.65	64.71	8.20	0.80
Low choice, %	29.41	20.59	6.93	0.42
Average choice, %	2.94	11.76	5.53	0.23
Yield grade	4.12	3.71	0.11	0.02
Yield grade 2, %	2.94	11.76	2.90	0.23
Yield grade 3, %	44.12	55.88	8.52	0.36
Yield grade 4, %	44.12	35.29	8.52	0.48
Yield grade 5, %	8.82	5.89	4.86	0.65

[a]Values reported are least squares means
[b]300 = slight, 400 = small

No treatment × period interactions were observed ($P \geq 0.16$) for average or maximum daily ruminal temperatures; therefore, main effects of treatment and period are reported (Table 3). Inclusion of ZH did not affect ($P \geq 0.64$) average or maximum daily ruminal temperature. Average and maximum daily temperatures increased ($P < 0.0001$) as the trial progressed. Average daily temperature increased ($P = 0.004$) by 0.06°F from period 1 to period 2, and increased ($P = 0.003$) by 0.12°F from period 2 to period 3. Maximum daily temperature increased ($P = 0.04$) by 0.05°F from period 1 to period 2, and increased ($P = 0.001$) by 0.13°F from period 2 to period 3. Minutes from 0900 to reach maximum daily temperature was not affected by ZH treatment ($P = 0.46$), but lower for period 3 than period 1 or 2 ($P < 0.001$).

Table 3. Effect of period and zilpaterol hydrochloride (ZH) on average and maximum daily ruminal temperatures, °F[a]

	Period[b]					Treatment[c]			
Item	1	2	3	SEM	*P*-Value	Control	ZH	SEM	*P*-Value
Average daily temperature	103.58[d]	103.64[e]	103.76[f]	0.05	<0.0001	103.68	103.64	0.06	0.64
Maximum daily temperature	104.40[d]	104.45[e]	104.58[f]	0.06	<0.0001	104.49	104.46	0.07	0.87
Minutes from 0900 to reach maximum daily temperature	777.7[d]	786.3[d]	624.7[e]	39.0	<0.0001	730.4	728.7	35.9	0.46

[a]Values reported are least squares means
[b]Period 1, Prior to ZH inclusion; Period 2, During ZH inclusion; Period 3, ZH withdrawal period
[c]Control, no ZH; ZH, 8.3 mg of ZH/kg DM
[def]Means with different superscripts within a row are different ($P < 0.05$)

There were no treatment × period interactions ($P \geq 0.27$) for time of maximum daily temperature occurrence; therefore, main effects of treatment and period are reported (Table 4). A greater ($P = 0.02$) percentage of steers reached their maximum daily temperature between 1500 and 1800 during period 1 compared with period 2, and a greater ($P = 0.04$) percentage of steers reached their maximum daily temperature between 2100 and 0000 during period 3 compared with period 2. Additionally, the percentage of steers reaching their maximum daily temperature between 0000 and 0300 increased ($P = 0.002$) by time period. This indicates that as the trial progressed, steers generally reached their maximum daily temperature later into the night compared to late in the afternoon. Environmental temperatures (Figure 1) decreased as the experiment progressed with mean daily temperatures of 46.9°F, 41.3°F, and 36.1°F during periods 1, 2, and 3, respectively. However, body temperatures increased as the experiment progressed. Therefore, differences in body temperature cannot be attributed to ambient temperature.

Table 4. Effect of period and zilpaterol hydrochloride (ZH) on percent distribution of time of maximum daily temperature occurrence[a]

	Period[b]					Treatment[c]			
Time interval	1	2	3	SEM[d]	*P*-Value	Control	ZH	SEM[d]	*P*-Value
0000-0300	13.37[e]	18.84[f]	24.26[g]	2.62	0.002	20.09	16.83	1.47	0.11
0300-0600	4.48	4.13	1.83	0.84	0.20	3.88	2.71	0.83	0.29
0600-0900	1.57	1.73	0.00	0.85	0.97	0.02	3.32	2.01	0.97
0900-1200	0.00	0.21	0.53	0.53	0.96	0.01	0.75	1.32	0.97
1200-1500	3.11	2.44	3.34	1.10	0.58	3.10	2.79	0.62	0.72
1500-1800	21.20[f]	17.56[ef]	12.98[e]	0.21	0.02	14.69[e]	19.53[f]	1.49	0.03
1800-2100	33.51	34.54	27.58	2.73	0.11	31.60	31.99	1.77	0.87
2100-0000	21.54[ef]	19.49[e]	26.66[f]	2.73	0.04	23.98	20.94	1.55	0.17

[a]Values reported are least squares means
[b]Period 1, Prior to ZH inclusion; Period 2, During ZH inclusion; Period 3, ZH withdrawal period
[c]Control, no ZH; ZH, 8.3 mg of ZH/kg DM
[d]Standard error of the mean
[efg]Means with different superscripts within a row are different ($P < 0.05$)

One treatment effect was observed in distribution of time of maximum daily temperature. Of steers reaching their maximum daily temperature between 1500 and 1800, a larger percentage ($P = 0.03$) was represented by ZH steers. This may indicate that the physiological effects of ZH have the potential to increase cooling of steers during the day. On average, most steers did not begin to cool down until the early evening, while feeding ZH caused body temperatures to cool down in the early afternoon. The environmental temperatures during this experiment were mild to cold, with low temperatures on some days falling below freezing. Future research may

investigate the effects of feeding ZH during the summer months, as the cooling effect may have practical implications during times of thermal stress.

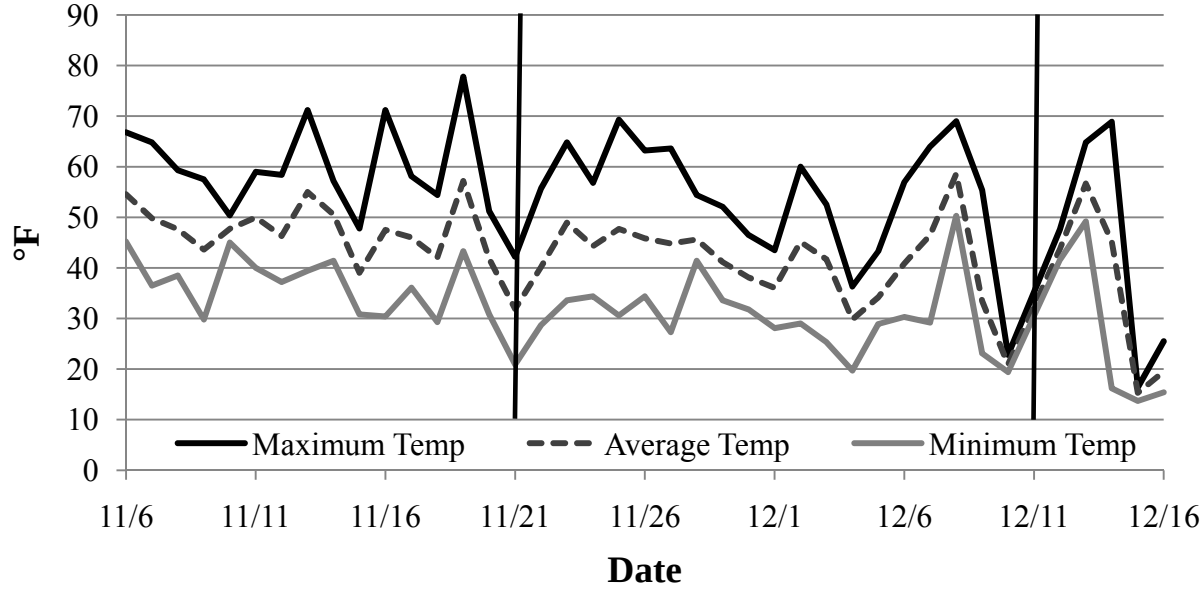

Figure 1. Maximum, average, and minimum environmental temperatures during the experiment. Vertical lines represent divisions between experimental time periods.

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