Zilpaterol Supplementation Improved Indicators of Well-Being, but not Growth in Heat-Stressed Red Angus Steers

Pablo C. Grijalva
Duarte E. Diaz
Samuel R. Garcia
Ty B. Schmidt
Jessica L. Petersen
Dustin T. Yates

Summary with Implications

The effects of zilpaterol (β2 agonist) supplementation on respiration rate, body temperature, growth, and carcass traits were studied in chronically heat-stressed feedlot steers. Through a collaborative partnership with the University of Arizona, Red Angus steers were heat stressed (90–105°F) and fed zilpaterol-supplemented rations (Thermoneutral control steers were pair-fed to the average feed intake of heat-stressed steers) for 30 days. Hot and cold carcass weights for heat-stressed cattle were 3% less than for controls, despite equal feed intake. Zilpaterol did not affect growth but improved the heat stress-induced hyperventilation and elevated body temperatures. Lighter carcass weights in heat-stressed cattle show that factors other than nutrient intake hinder growth under heat stress. Contrary to previous anecdotal reports, this study found no evidence that zilpaterol supplementation worsened the effects of heat stress. In fact, respiration rates and body temperatures show that zilpaterol moderates some responses to chronic heat stress in cattle.

Introduction

Heat stress is a hindrance to livestock performance. Livestock experience heat stress when their total heat load exceeds their dissipation rate. Increasing the concentrate content of the diet may help to make up for the negative energy balance caused by decreased feed intake in heat-stressed livestock. However, recent findings in sheep indicate that the impact of heat stress is due to more than just reduced feed intake.

Cattle feeders implement a range of strategies to maximize performance. One such option is dietary supplementation of growth promoters like zilpaterol HCl (i.e. Zilmax). This β2 agonist has been shown to break down fat, increase muscle synthesis, and inhibit muscle breakdown, thus increasing size and leanness of carcasses and improving feed efficiency. Zilpaterol was commonly used in US feedlots until anecdotal reports of increased wellbeing issues in stressed cattle in 2013 caused it to be removed from the market by the manufacturer. Therefore, the objective of this study was to determine if supplementing zilpaterol to cattle under heat stress conditions has detrimental effects on growth and on respiration rates and body temperatures, which are indicators of wellbeing.

Procedure

A cattle feeding study was performed with 24 Red Angus steers (572 ± 55 lbs) to evaluate the effects of feeding zilpaterol HCl during chronic heat stress on growth, respiration rates, rectal temperatures, and carcass traits. Steers were purchased from a commercial farm in Nebraska and transported to the University of Arizona Feedlot in Tucson, AZ. Upon arrival, steers were acclimated to diet and surroundings for several weeks, were halter-broken, and were trained to tie-stalls. Throughout the study, steers were fed an 88% concentrate diet composed primarily of ground-corn along with alfalfa hay (Table 1). These steers were randomly assigned to be housed indoors in adjacent stalls under heat stress (~105°F for 12 hours/day, 85°F for 12 hours/day; n = 12) or thermoneutral (~74°F constant; n = 12) conditions created by environmental chambers. In a 2 x 2 factorial, steers were also supplemented 0 or 3.81 mg/lb/day zilpaterol HCl (Intervet Merck) for 30 days. Steers were acclimated for 9 days in the environmental chambers before heat stress and supplementation began. Control steers were pair-fed to the average daily feed intake of heat-stressed steers. Respiration rates were estimated daily from single observations at 1500 by counting flank movements for 60 seconds. Body (rectal) temperatures were measured daily. Average daily feed intake, gain-to-feed ratios, and average daily gain were calculated for the 30-day period. Cattle were harvested in the abattoir of the University of Arizona Food Product and Safety Laboratory. Carcasses were weighed, chilled for 7 days, ribbed at the 12th rib, and carcass traits were measured. All growth and carcass data were analyzed for effects of environment, supplement, and their interaction by ANOVA using the mixed procedure of SAS. Respiration rates and body temperatures were analyzed by ANOVA, with day as a repeated measure. Because they were individually fed, steer was the experimental unit.

Table 1. Diet fed to Red Angus steers supplemented with zilpaterol HCl and heat stressed for 21 days.

Dietary Component	% of Diet, DM
Alfalfa, chopped	13.7
Corn, cracked	73.2
Mineral mix[1]	2.1
Molasses	6.3
Soybean meal	3.8
Urea	0.9

[1]Trace mineral-vitamin premix contained: Calcium Carbonate, Processed Grains, Sodium Chloride, Ammonium Sulfate, Potassium Chloride, Dicalcium Phosphate, Molasses, Magnesium Oxide, Zinc Sulfate, Ferrous Carbonate, Copper Sulfate, Magnesium Sulfate, Ferrous Sulfate, Sodium Selenite, Potassium Iodide, Cobalt, Carbonate, Vitamin A Acetate, and Vitamin E Supplement. (Manufactured by Maid Rite Feeds, Wilcox, AZ)

Results

By design, there were no differences among groups for initial body weight or

Table 2. Growth metrics and carcass traits in Red Angus steers supplemented with zilpaterol HCl and heat stressed for 21 days.

	Thermoneutral		Heat Stress		*P*-value		
Metric	Control	Zilpaterol	Control	Zilpaterol	Envir.	Suppl.	E*S
Growth							
Initial Bodyweight, lbs	561.4 ± 26	576.1 ± 17	578.3 ± 23	578.5 ± 14	NS	NS	NS
Final Bodyweight, lbs	663.0 ± 39	668.4 ± 22	689.3 ± 22	688.8 ±14	NS	NS	NS
Average Daily Gain, lbs/day	4.6 ± 0.3	3.8 ± 0.2	4.6 ± 0.2	4.6 ± 0.2	NS	NS	NS
Feed Intake, lbs/day	17.9 ± 0.3	17.9 ± 0.2	17.6 ± 0.3	18.5 ± 0.9	NS	NS	NS
Gain:Feed	0.48 ± 0.07	0.44 ± 0.02	0.53 ± 0.04	0.51 ± 0.04	NS	NS	NS
Carcass Traits							
Hot Carcass Weight, lbs	347.9 ± 4.0^{x}	357.6 ± 3.6^{x}	347.3 ± 3.5^{y}	340.4 ± 6.3^{y}	-	-	0.06
Cold Carcass Weight, lbs	339.2 ± 2.5^{a}	340.5 ± 4.2^{a}	333.7 ± 3.7^{b}	328.7 ± 5.6^{b}	-	-	0.05
Ribeye area, in^2	23.3 ± 0.6	22.0 ± 0.5	23.0 ± 0.5	23.0 ± 0.2	NS	NS	NS
Marbling[1]	200 ± 20	250 ± 20	200 ± 20	230 ± 20	NS	NS	NS
KPH fat, %	1.2 ± 0.6	1.0 ± 0.04	1.0 ± 0.03	1.0 ± 0.03	NS	NS	NS
Fat thickness, in	0.04 ± 0.005	0.05 ± 0.006	0.04 ± 0.005	0.05 ± 0.005	NS	NS	NS
Meat Color Score	6.8 ± 0.2	6.7 ± 0.2	6.8 ± 0.2	7.1 ± 0.2	NS	NS	NS

[1]Marbling score 200=Slight, 300=Small.

^{a,b} Means with different superscripts differ ($P < 0.05$). ^{x,y} Means with different superscripts tend to differ ($P < 0.10$).

NS, not significant.

Table 3. Respiratory rates and body temperatures in Red Angus steers supplemented with zilpaterol HCl and heat stressed for 21 days.

	Thermoneutral		Heat stress		*P*-value			
Variable	No Suppl.	Zilpaterol	No Suppl.	Zilpaterol	Env.	Suppl.	Day	E*S*D
Respiration, /min					NS	NS	NS	<0.01
Day 8	59 ± 3^{a}	56 ± 3^{a}	106 ± 5^{b}	95 ± 4^{c}				
Day 11	44 ± 4^{a}	45 ± 3^{a}	111 ± 6^{b}	92 ± 13^{b}				
Day 15	41 ± 4^{a}	29 ± 5^{c}	103 ± 10^{b}	95 ± 8^{b}				
Day 19	53 ± 5^{a}	41 ± 3^{c}	108 ± 6^{b}	105 ± 4^{b}				
Rectal Temp, °F					NS	NS	NS	<0.01
Day 8	101.3 ± 0.2^{a}	101.8 ± 0.2^{c}	102.7 ± 0.2^{b}	102.4 ± 0.4^{b}				
Day 11	101.7 ± 0.2^{a}	101.5 ± 0.4^{a}	103.3 ± 0.4^{b}	102 ± 0.4^{a}				
Day 15	101.7 ± 0.2^{a}	101.8 ± 0.2^{a}	103.3 ± 0.4^{b}	102.2 ± 0.4^{a}				
Day 19	101.7 ± 0.2^{a}	101.5 ± 0.4^{a}	103.5 ± 0.2^{b}	102.6 ± 0.4^{c}				

$^{a-b}$ Means with different superscripts differ (P < 0.05) within day.

feed intake. There were also no differences among groups for final bodyweight, average daily gain, or feed efficiency or for the carcass traits ribeye area, marbling, color, fat thickness, and kidney pelvic and heart percentage (Table 2). Heat stress caused hot carcass weights to be 3% lighter ($P = 0.06$) and cold carcass weights to be 3% lighter ($P = 0.05$) than in controls, regardless of zilpaterol supplementation. Environment x supplement x day interactions were observed ($P < 0.05$) for body temperature and respiration rates (Table 3). In general, heat stress caused body temperatures to increase ($P < 0.05$) by 1 to 2°F. Zilpaterol supplementation reduced ($P < 0.05$) the elevation in body temperature in heat-stressed cattle in the last half of the 30-day period but not earlier in the period. Heat stress caused respiration rates to increase ($P < 0.05$) by up to 28%, but zilpaterol supplementation reduced ($P < 0.05$) hyperventilation by about half.

Conclusions

Beef steers produced an average of almost 10 lbs less carcass when exposed to heat stress for three weeks, even when feed intake was made equivalent by pair-feeding. This demonstrates that factors independent of nutrient intake impair growth in heat-stressed cattle. Furthermore, zilpaterol supplementation helped reduce the hyperventilation and high body temperatures caused by heat stress. This provides evidence that zilpaterol alleviates some of the physiological effects of heat stress. Although the timeline for future market availability is unclear, this study indicates a potential role for controlling some negative outcomes of long-term heat stress in food animals.

Pablo C. Grijalva, graduate student

Duarte E. Diaz, associate professor (University of Arizona)

Samuel R. Garcia, assistant professor (University of Arizona)

Ty B. Schmidt, associate professor

Jessica L. Petersen, associate professor

Dustin T. Yates, associate professor