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Effects of Shade and Feeding Zilpaterol Hydrochloride to Finishing Steers on Performance, Carcass Quality, Heat Stress, Mobility, and Body Temperature

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Summary

A finishing study evaluated the effects of shade and feeding zilpaterol hydrochloride (ZH) on performance, carcass quality, mobility, and body temperature. No effect on body temperature, or performance was observed for shaded cattle versus cattle in open pens. Feeding ZH increased HCW, LM area and decreased yield grade. Zilpaterol hydrochloride increased respiration rate but did not significantly affect body temperature or mobility. Across all treatments mobility decreased with time, therefore, cattle were least mobile at the time of harvest.

Introduction

Zilpaterol hydrochloride (ZH; Merck Animal Health; De Soto, KS.) is a β adrenergic-agonist approved for feeding to beef cattle in the United States in 2006 (FDA, 2006). Zilpaterol hydrochloride was heavily utilized in the United States feedlot industry since its release. Recently, some have raised concerns of animal welfare issues with the feeding of ZH, which resulted in it being removed from the market by the manufacturer. Performance responses from feeding ZH during the end of the finishing phase are well characterized and clearly show beneficial responses in HCW. A 33 lb increase in HCW along with increased dressing percentage and decreased USDA yield grade have been consistently observed when ZH was supplemented at the end of the feeding period (Journal of Animal Science, 93:2285–2296; PLoS ONE, 9(12):e0115904; Journal of Animal Science, 86:2005–201). However, there are few studies evaluating the effect of ZH on animal welfare issues, such as heat stress and mobility of cattle. Therefore, the objective of this study was to further investigate the impact of feeding ZH on heat stress, mobility, and body temperature, in addition to performance and carcass characteristics for steers fed in open or shaded pens.

Procedure

Four hundred and eighty crossbred beef steers (initial BW = 793 lb; S.D. = 88 lb) were fed at the US Meat Animal Research Center (USMARC) feedlot near Clay Center, Neb. Cattle were started on finishing diets on January 2, 2014. The diet consisted of 57.35% DRC, 30% WDGS, 8% alfalfa hay, 4.25% supplement, and 0.04% urea for all pens and treatments. Zilpaterol hydrochloride (Merck Animal Health; De Soto, KS) was fed through the supplement according to the label at 7.56 g/ton of diet DM and the inclusion rate was confirmed by laboratory testing. Zilpaterol hydrochloride was fed for 21 days with a 4 day (block1) or 3 d (block 2) withdrawal prior to harvest.

Cattle were implanted with a Revalor XS (200mg trenbolone acetate, 40mg estradiol; Merck Animal Health) and individual BW was collected on January 28, 2014. At this time, cattle were divided into 2 blocks based on a previous BW. The blocks were based on differences in BW and were labeled heavy (block 1) or light (block 2) and the weight difference between blocks was 116 lb (unshrunk BW). The artificial shade used during the study was comprised of poles 32.8 ft tall by 50.5 ft long that were placed in the fenceline. The north/south structures were equipped with four 50.5 ft lengths of poly snow-fence and provided 50% shade coverage. The shade structures tracked the sun during the day and offered 32.3 ft^2 of shade per animal. The other eight pens were unshaded.

The experiment was designed as a randomized block with a 2 × 2 factorial arrangement of treatments. Factors consisted of housing type (shaded or unprotected open lot pens) and the inclusion of ZH (0 or 7.56 g/ton of DM for the last 21 days of the finishing period). Cattle were blocked by initial BW and assigned randomly to pen (within housing type) and pen was assigned randomly to ZH treatment. Treatments were applied at the end of the finishing period for both blocks and staggered so that cattle could be harvested in the warmest weeks of summer (mid-July and early August).

Both blocks of cattle received a SmartStock (SmartStock; LLC. Pawnee, OK) temperature monitoring rumen bolus one d prior to the initiation of feeding ZH. The rumen boluses were set to record rumen temperature in 10 min intervals. Rumen temperatures were transmitted from the boluses to a computer via a receiver located in the animal's home pen, thus temperature recording stopped when animals left their home pens. After an adaptation period to humans prior to initiating ZH feeding, panting scores (0 = no panting, 4 = severe stress) and respiration rates were taken daily by trained individuals during the ZH feeding phase of the study starting at 1300. Respiration rates were recorded as the amount of time it took the animal to take 10 breaths and these data were then used to calculate breaths/min. Prior to ZH feeding, one-half of the cattle in each pen were selected and identified with a uniquely colored ear tag. One-half of the animals in each pen were evaluated individually on a daily basis such that each one-half of the animals in each pen were evaluated every other day. Panting scores and respiration rates were taken by a team of 2 people and the first pen observed rotated daily to minimize time of day effects.

Mobility scores were collected 10 times throughout the ZH feeding period. These scores were based on the 0 to 4 (0 = no lameness and 4 = severe lameness) Tyson mobility scoring system (Tyson Foods; Springdale, AR). The observation times included leaving their home pens, as

they were loaded on the truck leaving the feedlot, during unloading at the abattoir, and as they were moved into holding pens at the abattoir. Cattle were held at the packing plant overnight and on the day of harvest mobility scores were collected during antemortem inspection, as cattle left the holding pen, and as cattle were moved to the restrainer. Mobility scores were then compiled to create four time points; before ZH, after ZH, arrival at the abattoir, and time of harvest by the same technician at each time point.

Performance data, carcass characteristics, respiratory rate, and chute exit velocity, were analyzed using the MIXED procedure of SAS (SAS Institute, Inc. Cary, N.C.) with pen as the experimental unit. Mobility scores were analyzed using the GLIMMIX procedure of SAS (SAS Institute, Inc.) with pen as the experimental unit. The model included fixed effects of dietary treatment (fed ZH or not), time point of observation, housing type (open or shade), the interaction of dietary treatment and time, and the interaction of dietary treatment and housing type. Body temperature was analyzed using the GLIMMIX procedure of SAS (SAS Institute, Inc.) with animal as the experimental unit. The model included the fixed effects of day, dietary treatment (fed ZH or not), housing type (open or shade) and the interaction of dietary treatment and housing type and a random animal effect and residual. Body temperature measurements were characterized as average, maximum, area under the curve, and area over the curve.

Table 1. Main effects of zilpaterol hydrochloride (ZH) feeding and housing type on performance and carcass characteristics of summer fed steers

Trait	Control	Zilmax	*P*-value[a]	Open	Shade	*P*-value[b]	Interaction	SEM
Performance								
Initial BW, lb	790	794	0.37	794	788	0.24	0.72	3
Final BW, lb	1408	1417	0.43	1421	1401	0.08	0.90	7
DMI, lb/d	21.3	21.1	0.61	21.03	21.3	0.55	0.26	0.2
ADG, lb	3.41	3.43	0.56	3.45	3.39	0.10	0.68	0.03
F:G	6.29	6.17	0.44	6.17	6.29	0.39	0.53	—
Carcass Characteristic								
HCW, lb	895	926	< 0.01	917	904	0.17	0.61	6
Dressing %	63.7	65.4	< 0.01	64.5	64.6	0.78	0.29	0.2
LM area, in[b]	13.7	14.7	< 0.01	14.4	14.1	0.27	0.59	0.1
12th Rib Fat, in	0.64	0.61	0.15	0.64	0.62	0.39	0.54	0.01
Marbling[c]	476	469	0.50	472	473	0.92	0.67	7
USDA YG[d]	3.5	3.2	< 0.01	3.4	3.4	0.89	0.68	0.06
Non-performance characteristics								
Respiration, breaths/min	92.3	100.8	0.05	96.3	96.9	0.88	0.69	2.93
Panting Score[e]	0.55	0.68	0.10	0.62	0.62	0.99	0.31	0.05

[a]Main effect of ZH inclusion.
[b]Main effect of housing type.
[c]300 = slight, 400 = Small, 500 = Modest.
[d]Calculated as 2.5 + (6.35 × 12th rib fat) + (0.2 × 2.5[KPH]) + (.0017 x HCW) − (2.06 × LM Area) USDA, 1997.
[e]Panting scores based on 0–4 scale with 0 = no panting and 4 = severe distress.

Results

There were no ZH x Housing interactions ($P \geq 0.26$) observed for performance, carcass characteristics, panting scores or respiration rate (Table 1). Initial BW, final live BW, F:G, DMI, and ADG was not different between dietary treatments ($P \geq 0.37$). There was a tendency for cattle fed in open lot pens to have a greater final live BW ($P = 0.08$) and ADG ($P = 0.10$) than cattle in shaded pens; however, there was no difference in DMI or F:G between housing type (P < 0.24). For cattle fed ZH, HCW, dressing percent, and LM area were greater ($P < 0.01$) compared to control cattle. However, there was no difference ($P > 0.17$) between shaded and open lot cattle for HCW, dressing percent, yield grade, and LM area. Twelfth rib fat thickness and marbling score were not different ($P \geq 0.15$) between dietary treatments or housing types. Control cattle had a greater ($P < 0.01$) USDA yield grade compared to cattle fed ZH. There was no difference ($P = 0.89$) due to housing type for USDA yield grade.

There was no ZH × housing interaction ($P > 0.31$) for respiration rates or panting scores so only main effects are presented (Table 1). Cattle fed ZH had greater respiration rates ($P = 0.05$) than cattle fed the control diet. Respiration rates were not different ($P = 0.88$) due to housing type. There was a tendency ($P = 0.10$) for cattle fed ZH to have a greater panting score over the control group but panting scores were not different ($P = 0.99$) between housing types. These data are consistent with the ZH feed label (Merck Animal Health) that states increased respiration rates may be observed in conjunction with ZH feeding.

There was no ZH × housing or ZH × time interactions ($P > 0.14$) observed for mobility score. Consequently, only the main effects of dietary treatment and time for mobility are presented. There were no differences in mobility between the control cattle and ZH fed cattle for the percentage of animals scoring 0 ($P = 0.91$) or 0 and 1 ($P = 0.21$; Table 2). There was no ZH × housing or ZH × time interactions ($P > 0.48$) for chute exit velocity. Cattle fed the control diet compared to ZH were not different in chute exit velocity ($P = 0.68$; Table 2). These data are similar to findings by Bernhard et al. (Proc. 2014 Plains Nutrition Council Spring Conference, San Antonio, TX. Page 142) where it was noted that feeding ZH did not affect chute exit velocity or mobility score.

Time had a significant effect ($P < 0.01$) on overall cattle mobility with mobility being greatest earlier in the feeding period and decreasing over time up to harvest (Table 3). Additionally, time also had a significant effect ($P < 0.01$) on chute exit velocities with cattle taking more time to travel 26 feet at the end of the study as compared to the beginning of the study. Housing did not affect mobility ($P > 0.70$; data not presented). Combined, these data suggest that cattle mobility decreases as

cattle gain weight and that transport and standing on concrete at the abattoir further exacerbates mobility problems.

Body temperature data are presented in Table 4. There were ZH × housing interactions ($P < 0.01$) observed for body temperature. Feeding ZH in open and shaded pens decreased average and maximum body temperature, relative to the control group ($P < 0.01$). Cattle fed ZH in open pens had the lowest average body temperature followed by cattle fed ZH in shaded pens, control cattle in shaded pens, and control cattle in open lot pens with the greatest average body temperature ($P < 0.05$). Maximum body temperature followed this same pattern with cattle fed ZH in open lot pens having the lowest body temperature followed by cattle fed ZH in shaded pens, control cattle in shaded pens, and control cattle in open lot pens having the greatest maximum body temperature ($P < 0.05$). Area under the curve, which indicates the average magnitude of body temperature each d, also followed the same pattern as average and maximum body temperature. Area over the curve, area of body temperature greater than the average of the steer's respective home pen, did not differ ($P = 0.65$) in shaded pens when animals were fed ZH or the control diet. In shaded pens, both ZH and control had the lowest area over the curve with animals fed ZH in open lot pens intermediate and control animals in open lot pens having the greatest area over the curve ($P < 0.05$).

In the current study the use of ZH for 21 d at the end of the feeding period increased HCW, dressing percent, LM area, and decreased yield grade. Shade had little impact on cattle performance or carcass characteristics in the current trial. While respiration rates and panting scores were greater for cattle fed ZH, average and maximum body temperature for cattle fed ZH were lower than that of the control. However, it is important to note that while the differences in body temperature between treatments are statistically different, biologically the observed change in body temperatures are irrelevant. This suggests that the inclusion of ZH had little impact on the heat load experienced by the animal. Overall, no impact was observed for feeding ZH on cattle mobility, however; with time, mobility decreased for all cattle up until harvest. Based on the observations in this study we concluded that the use of ZH improved carcass weight with little impact on body temperature or mobility suggesting that animal welfare was not affected by feeding ZH during the last 21 days of the feeding period.

Table 2. Main effect of Zilpaterol Hydrochloride (ZH) on mobility score calculated as the proportion of animals in a treatment that received the score[a]

Item	Control	ZH	SEM	*P*-value
0 score, %	90.49	90.63	0.81	0.91
0 and 1 score[b], %	99.00	98.44	0.34	0.21
CEV[c]	4.94	5.02	0.15	0.68

[a]Mobility scores are based on the Tyson mobility scoring system where 0 is no lameness and 4 is non-ambulatory.
[b]The percentage of animals receiving a score of 0 or 1 added together. The percentage of animals that scored a 2 can be calculated as 100%-% of 0 and 1 scores together.
[c]CEV = Chute exit velocity reported as seconds to travel 26 ft.

Table 3. Main effect of Time on mobility score calculated as the proportion of animals in a treatment that received the score[a]

Item	Before ZH[b]	After ZH[b]	Unloading at Plant	Up to Restrainer	SEM	Interaction[c]	*P*-value[d]
0, %	95.01[g]	90.78[h]	88.42[hi]	85.56[i]	1.27	0.14	< 0.01
0 and 1[e], %	98.99[g]	99.42[g]	98.54[gh]	97.16[h]	0.61	0.49	< 0.01
CEV[f]	4.65	5.32	N/A	N/A	0.11	0.84	< 0.01

[a]Mobility scores are based on the Tyson mobility scoring system where 0 is no lameness and 4 is non-ambulatory.
[b]ZH = Zilpaterol Hydrochloride
[c]*P*-value for the time × ZH interaction.
[d]*P*-value for the effect of time on mobility.
[e]The percentage of animals receiving a score of 0 or 1 added together. The percentage of animals that scored a 2 can be calculated as 100%-% of 0 and 1 scores together.
[f]CEV = Chute exit velocity reported as seconds to travel 26 ft.
[g,h,i]Values within row with unique superscripts differ $P < 0.05$

Table 4. Simple-effect means for cattle body temperature observed during the presence of a zilpaterol hydrochloride (ZH) × housing interaction

Measurement	Open		Shade		SEM	*P*-value[a]
	Control	Zilmax	Control	Zilmax		
Average, °F	102.44[g]	102.16[d]	102.38[f]	102.35[e]	0.01	< 0.01
Max, °F	104.56[g]	104.21[d]	104.47[f]	104.30[e]	0.02	< 0.01
AOC BT[b]	340.14[f]	237.94[e]	124.49[d]	122.74[d]	2.75	< 0.01
AUC BT[c]	14752[g]	14711[d]	14743[f]	14738[e]	2	< 0.01

[a]*P*-value of the ZH × Housing type interaction.
[b]AOC = Area over the curve which indicates the area of body temperature greater than the average of the steer's respective home pen.
[c]AUC = Area under the curve which indicates the average magnitude of body temperature each d.
[d,e,f,g]Values within rows with unique superscripts differ $P < 0.05$.

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