Feeding β-agonists under heat stress conditions in beef cattle

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Abstract

Red Angus steers (n=24; 260 ± 25 kg) were used to analyze the effects of supplementation of zilpaterol hydrochloride (ZH) under heat stress conditions on respiration rate (RR), rectal temperature (RT), growth performance (GP), and carcass traits (CT). Steers were randomly assigned to a 2 x 2 factorial treatment arrangement (n=6/group) with factors including heat stress (HS; THI=71 to 83) or thermal neutral (TN; THI=27 to 39) conditions and with/without supplementation of ZH (0 or 8.38 mg/kg/d on 88% DM basis). Steers were provided 9 d to acclimate to tie stalls rooms under TN conditions before starting the study. TN steers were pair-fed to the average daily dry matter intake (DMI) of HS steers. *Ad libitum* water consumption (WC) was recorded daily. HS and TN steers were harvested on d 22 and 23, respectively. By design, DMI was not different between environments (P=0.43). DMI also did not differ between supplement groups (P=0.31). RT, RR, and WC were greater (P<0.01) in HS steers compared to TN steers. There was a supplement by environment interaction (P=0.02) for RT, as HS steers fed ZH had lower RT than HS control steers (39.1 vs 39.5 °C). ADG was 20% higher (P=0.04) in HS steers compared to TN steers. CT did not differ (P=>0.05) due to environment, treatment, or interactions between environment and ZH supplementation. Our results suggest that feedlot steers under our experimental conditions display some sensitivity to HS through GP, RR, and RT, however, this did not translate to an impact on CT. Furthermore, ZH supplementation under HS conditions appears to impact thermoregulatory responses positively, yet this did not impact GP or CT.

Introduction

Zilpaterol hydrochloride (ZH) is a B-adrenergic agonist (BAA) that was commonly used in the United States feedlot industry between 2006 and 2013 until it was removed from the market by the manufacturer. Anecdotal accounts indicated that cattle fed ZH had higher levels of stress, mortality rate, and lameness upon arrival at the packing plants, especially during the summer months.

Beta-agonists bind to G protein coupled receptors on fat and muscle cell surfaces and stimulate lipolysis and protein synthesis while inhibiting lipogenesis and proteolysis (Strydom et al., 2009). This has been reported to increase overall leanness of the carcass as well as dressing percentage without an increase in feed intake, however, ZH supplementation has been reported to negatively affect eating quality, specifically by reducing marbling and tenderness score (Vasconcelos et al., 2008; Avendaño-Reyes et al., 2006).

The adrenergic system that is stimulated in order to increase muscle accretion in ZH fed cattle, is the same pathway that is stimulated when cattle are exposed to heat stress conditions (Swanson et al., 2019). Heat stress is known to decrease animal performance and well-being (Diaz et al., 2018). Therefore, the objective of this study was to determine the effects simultaneous stimulation of the adrenergic system through supplementation of ZH and exposure to heat stress conditions has on animal well-being, non-performance parameters, growth performance, and carcass traits.

Experimental Design

Twenty four red Angus steers (260 ± 25 kg) were randomly assigned to a 2 x 2 factorial treatment arrangement (n=6/group) with factors including heat stress (HS; THI=71 to 83) or thermal neutral (TN; THI=27 to 39) conditions and with/without supplementation of ZH (0 or 8.38 mg/kg/d on 88% DM basis).

Steers were provided 9 d to acclimate to tie stalls rooms in environmental chambers at the University of Arizona's Agricultural Research Center (Tucson, AZ) under TN conditions before starting the study. TN steers were pair-fed to the average daily dry matter intake (DMI) of HS steers. *Ad libitum* water consumption (WC) was recorded daily. Respiration rate and rectal temperature were recorded daily. Respiration rate was measured by counting flank movements for 60 s. Rectal temperatures were measured using standard digital thermometers. Average daily water consumption, gain:feed, and average daily gain were calculated at the end of the experimental trial. HS and TN steers were harvested on d 22 and 23, respectively.

Data were analyzed using the PROC MIXED procedure (SAS Institute Inc., Cary, NC, USA). Independent variables included treatment and environment and their respective interactions. Tendencies were declared (0.05>P<0.1). Significance was declared at (P<0.05). When significant effects were observed, differences between the means were evaluated.

Results

Table 1. Main effect means of feeding ZH under HS and TN conditions in experimental steers.

Item	Heat Stress		Thermal Neutral		SEM	P-value		
	ZH	Control	ZH	Control		Environment	Treatment	Environment * Treatment
Performance charcateristics								
DMI, kg/d	7.3	7.1	7.2	6.8	0.29	0.50	0.29	0.90
ADG, kg	2.3	2.1	1.9	1.9	0.18	0.03	0.84	0.37
F:G	3.5	3.6	4.4	4.3	0.14	0.054	0.96	0.91
Water Intake (L/day)	35.3	34.5	23.0	21.8	3.64	0.003	0.79	0.96
Carcass Characteristics								
HCW, kg	159.4	159.8	159.1	152.9	5.86	0.54	0.63	0.58
CCW, kg	153.9	153.5	151.5	149.2	5.82	0.57	0.82	0.87
KPH %	0.01	0.01	0.01	0.01	0.0004	0.20	0.20	0.20
LM area, cm^2	59.7	58.9	55.0	57.9	1.49	0.07	0.49	0.24
Marbling Score	233.3	200.0	250.0	200.0	21.10	0.70	0.06	0.70
Nonperformance characteristics								
Respiratory Rate (breaths/min)	98.9	104.7	45.4	52.6	3.16	<0.0001	0.06	0.83
Rectal Temperature (C)	39.1[a]	39.5[b]	38.6[ab]	38.5[ab]	0.09	<0.0001	0.13	0.02

[a-b] Means within a row followed by different letters differ at P < 0.05

Figure 1. Steers were housed in environmental chambers at the University of Arizona's Agricultural Research Complex (Tucson, AZ). All steers were given 9 d to acclimate to tie stall rooms.

Figure 2. Steers were harvested at the University of Arizona Food Product and Safety Lab. Carcasses were then chilled for 7 d and graded for quality and yield.

Conclusion

Literature evaluating the interacting effects of ZH supplementation and exposure to heat stress conditions is limited. Results of this study suggest that feedlot steers under our experimental conditions display some sensitivity to HS through GP, RR, and RT, however, this did not translate to an impact on CT or overall animal well being. Furthermore, ZH supplementation under HS conditions appears to impact thermoregulatory responses positively, yet this did not impact GP or CT. Further experimentation is needed to determine the effect simultaneous stimulation of the adrenergic system through ZH supplementation and heat stress exposure has on animal well being, performance, and carcass characteristics.

References

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