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Summary

Angus steer calves (n=135) were used in a 55d feedlot growing study to investigate the effects of feeding schedule on tympanic temperature response when limit feeding. Steers were fed a high moisture ear corn diet (58 Mcal/cwt NEg) at 0900h (AM), 1500h (PM) or 50% at 0900h and 50% at 1500h (SPLIT) to allow for 2.50lb ADG. Climatic data were collected at 30 min intervals throughout the study via an on site automated weather station. Tympanic temperatures (TT) were collected every 30 min (5 steers/trt) for 5d (d44 to d48). Mean ambient temperature during the 5d TT collection period was -6.5^{0}F (-23.1 to 9.1^{0}F). After 55d, BW (802, 808 and 802lb), ADG (2.56, 2.67 and 2.52lb) and feed efficiency (5.73, 5.52 and 5.87) did not differ (P>.10) between AM, PM and SPLIT respectively, but followed rankings of previous research. Diurnal TT patterns were assessed by separating the day into three periods based on mean hourly wind chills (44.2, 17.8 and 7.5^{0}F) for Period 1 (0800 to 1600h), Period 2 (1630 to 2100h) and Period 3 (2130 to 0730h) respectively. Peak TT occurred during Period 2 for AM (102.4^{0}F) and Period 3 for PM (103.2^{0}F). SPLIT fed steers exhibited TT peaks of 103.9^{0}F or greater in each period. These data indicate that by adjusting feeding schedule it is possible to alter the time at which peak TT may occur, so that peak TT coincides with colder periods of the day. Elevated TT across all periods for SPLIT suggests that these steers may have increased metabolic rate to maintain normal TT during extreme cold. Additional research is needed to explain the changes in TT and how feeding times may impact energy partitioning.

Introduction

In the Northern plains of the United States the average January temperature is below 32^{0}F. These cold weather conditions present challenges for young feedlot animals. The acclimation of feedlot animals to winter conditions occurs generally at the cost of an increase in resting metabolic rate, which is required to maintain body temperature. As a consequence less feed energy is available for growth. Feed intake is increased during chronic cold exposure when animals have unlimited access to feed, and this may compensate in part for the increased energy requirement (Scott et al., 1993). Restricting feed intake of high energy diets has been researched. Most of this research has been focused on restricting intake of high energy diets as an alternative management practice to full feeding high roughage diets during the growing phase (Loerch, 1990; Sip and Pritchard, 1991). These studies reported improved feed efficiency and reduced cost of gain for limit-fed cattle compared to those fed ad libitium. Under cold exposure it may be possible to better utilize heat of fermentation by altering feeding time when cattle are limit-fed to help maintain body temperature. The objective of this study was to determine the effect of feeding schedule on tympanic temperature responses of limit-fed growing feedlot steers during winter.

Materials and Methods

Angus steer calves (n=135) from a single source were used in the 55 d growing study. Steers were blocked by weight and randomly assigned to one of three feeding schedules; feed delivered once daily at approximately 0900h (AM); feed delivered once daily at approximately 1500h (PM) or feed delivered twice daily at approximately 0900 and 1500h (SPLIT).

All steers had previously been vaccinated against IBR, BVD, PI_3, BRSV, Haemophilus

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[2] Post Doctorate
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(Resvac-4, Pfizer, Exton, PA), 7-way clostridia (Ultrabac-7, Pfizer, Exton, PA) and treated for parasites (Cydectin, Fort Dodge Animal Health, Fort Dodge, IA). All steers were allowed 28 days in a receiving program prior to the initiation of this study. Individual body weights were recorded at the start of the study and all steers were implanted (Synovex S, Fort Dodge Animal Health, Fort Dodge, IA) at that time. Interim body weights were collected on all steers every 14 d and a final body weight was recorded on d 55.

Steers were limit-fed a high moisture ear corn diet (58 Mcal/cwt NEg) to allow for 2.5lb ADG (Table 1.). Calculations of NEg required were derived using NRC equations and tabular values for ingredients. Dry matter intake was adjusted every 14 d for corresponding changes in body weight.

Tympanic temperature loggers were placed into 5 randomly selected steers per treatment. Tympanic temperature readings were recorded every 30 minutes to the loggers for 5 consecutive days (d 44 to d 48). The loggers were then retrieved and the data were downloaded to a computer for analysis. Diurnal TT patterns were assessed by separating the day into three time periods based on mean hourly wind chills (44.2, 17.8 and 7.5^{0}F) for Period 1 (0800 to 1600h), Period 2 (1630 to 2100h) and Period 3 (2130 to 0730h) respectively.

Weather information was collected throughout the 55 d growing study via a wireless weather station (Davis Instruments, CA) located centrally within the feedlot facility. Ambient temperature (^{0}F), Black globe temperature (^{0}F) and wind speed (mi/h) were recorded every 30 min. The black globe thermometer consists of a 6-inch sphere of copper painted matte black on the outside. A temperature sensor is inserted into the globe and is centered at the midpoint of the globe. The purpose of the black globe thermometer is to combine the thermal effects of the radiation from the sun and hot surfaces in the environment into a single reading. Wind chill temperature was calculated based on the NOAA's National Weather Service equation, substituting black globe temperature for ambient temperature.

$$\text{Wind Chill } (^0\text{F}) = 35.74 + 0.6125T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where; T – Black globe temperature (^{0}F)
V – Wind speed (mph)

All data were compared using methods appropriate for a completely randomized block design using the GLM procedure of SAS (1996).

Results and Discussion

During the 55 d growing study ambient temperature ranged from -23 to 55^{0}F, with a mean of 17.2^{0}F (Table 2.). Mean black globe temperature was 20^{0}F and ranged from -24 to 67^{0}F, while wind speed ranged from 0 mph to 20 mph with a mean of 4.1 mph. Mean wind chill was 16.1^{0}F and ranged from -28 to 67^{0}F. During the 5 d tympanic temperature collection period (d44 to d48) mean ambient temperature was -6.5^{0}F (-23 to 9^{0}F), while mean wind chill was -5.2^{0}F (-28 to 28^{0}F)(Figure 1).

Initial body weights and final body weights did not differ ($P < 0.05$) between treatment groups (Table 3.). However, body weights at d 28 were greater ($P > 0.05$) for PM than AM or SPLIT treatment groups. This trend was also observed at d 14 and d 42 where body weights were greater ($P < 0.1$) for PM than AM or SPLIT treatment groups. Numerical rankings of ADG and F:G were consistent with these other production variables but were not different ($P > 0.10$). Maintenance energy requirements over the 55 d growing study were 5.6 and 7.6% higher for AM and SPLIT treatment groups compared to PM. This may, in part, explain the improvements in performance.

Diurnal TT patterns were assessed by separating the day into three time periods based on mean hourly wind chills (44.2, 17.8 and 7.5^{0}F) for Period 1 (0800 to 1600h), Period 2 (1630 to 2100h) and Period 3 (2130 to 0730h) respectively. During the daytime hours (Period 1), peak TT was highest ($P < 0.0001$) for SPLIT (104.0^{0}F), lowest for AM (102.0^{0}F) with PM (102.2^{0}F) being intermediate (Figure 2). Similar rankings occurred in Period 2 (early evening). However, a small increase in TT for AM (102.4^{0}F) and a similar decrease for SPLIT (103.9^{0}F) was observed with colder temperatures, compared to an increase of 0.9^{0}F for PM (103.1^{0}F). During the coldest portion of the day (Period 3), AM treatment group had a lower TT ($P < 0.0001$), than PM and SPLIT treatment groups (101.8, 103.2 and 104.3^{0}F, respectively). This would suggest that AM fed cattle are not able to maintain TT during the colder late evening/early morning hours. PM fed cattle were able to maintain a higher body temperature by possibly taking advantage of heat generated from fermentation. SPLIT fed cattle tended to maintain an abnormally high TT throughout all three periods. This may suggest that SPLIT fed cattle attempt to compensate for failure to maintain normal TT by increasing metabolism which in turn raises body temperature above normal levels.

Implications

The data collected from this study indicate that by adjusting feeding schedule it is possible to alter the time at which peak TT may occur, so that peak TT coincides with colder periods of the day. Elevated TT across all periods for SPLIT suggests that these steers may have increased their metabolic rate to maintain normal TT during extreme cold. Additional research is required to explain how changes in feeding schedules may influence energy partitioning.

References

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Loerch, S. C. 1990. Effects of feeding growing cattle high-concentrate diets at a restricted intake on feedlot performance J. Anim Sci. 1990 68: 3086-3095.

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Tables

Table 1. Diet Formulation[ab]

High moisture ear corn, %	82.83
SBM[c], %	13.00
Wheat midds[c], %	2.16
Limestone[c], %	1.30
TM Salt[c], %	0.30
Zinc Sulfate[c], %	0.008
Copper Sulfate[c], %	0.003
Potassium Chloride[c], %	0.4
CP, %	12.87
NDF, %	25.12
NEm, Mcal/lb	0.88
NEg, Mcal/lb	0.58

[a] DM basis.
[b] 23g/T monensin, 1000IU/lb Vit A and 10IU/lb Vit E was provided in the diet.
[c] Provided as pelletted supplement.

Table 2. Mean daily (± SD) climatic conditions during the study

Item	Average	Minimum	Maximum	SD
Period 1 (d 1-14)				
Ambient temperature, ^{0}F	28.67	5.8	47.7	7.96
Wind chill[a], ^{0}F	28.52	1.24	67	11.70
Wind speed, mph	4.02	0	20	3.82
Black globe temperature, ^{0}F	31.43	4	67	11.40
Period 2 (d 15-28)				
Ambient temperature, ^{0}F	15.81	-10	46.4	13.34
Wind chill[a], ^{0}F	13.71	-19.32	61.96	15.92
Wind speed, mph	4.39	0	20	3.94
Black globe temperature, ^{0}F	18.48	-13	62	15.58
Period 3 (d 29-42)				
Ambient temperature, ^{0}F	13.34	-7.2	54.8	12.02
Wind chill[a], ^{0}F	12.05	-18.99	61.3	14.95
Wind speed, mph	3.82	0	17	3.54
Black globe temperature, ^{0}F	16.31	-8	63	13.70
Period 4 (d 43-55)				
Ambient temperature, ^{0}F	10.4	-23	42.1	16.28
Wind chill[a], ^{0}F	9.58	-28.13	67	18.71
Wind speed, mph	4.31	0	18	4.27
Black globe temperature, ^{0}F	14.46	-24	67	18.16
Overall (d 1-55)				
Ambient temperature, ^{0}F	17.18	-23	54.8	14.47
Wind chill[a], ^{0}F	16.08	-28.13	67	17.18
Wind speed, mph	4.13	0	20	3.90
Black globe temperature, ^{0}F	20.27	-24	67	16.04

[a]Wind Chill (^{0}F) = $35.74 + 0.6125T – 35.75(V^{0.16}) + 0.4275T(V^{0.16})$, where; T – Black globe temperature (^{0}F), V – Wind speed (mph).

Table 3. Performance data

	AM	PM	SPLIT	sem
Initial BW, lb	661	662	663	1.3
Day 1-14				
BW (day 14), lb	716[c]	724[d]	720[cd]	2.1
DMI, lb	14	14	14	
ADG, lb	3.94	4.44	4.02	0.16
F/G	3.55	3.16	3.49	0.132
Day 15-28				
BW (day 28), lb	750[a]	761[b]	756[ab]	2.5
DMI, lb	14.6	14.7	14.7	0.05
ADG, lb	2.46	2.68	2.62	0.174
F/G	6.17	5.51	5.67	0.399
Day 29-42				
BW (day 42), lb	793[c]	803[d]	798[cd]	3
DMI, lb	14.9	14.9	14.9	
ADG, lb	3.05	3.00	2.99	0.164
F/G	4.92	5.03	5.03	0.293
Day 43-55				
BW (day 55), lb	835	842	835	3.1
DMI, lb	15.4	15.4	15.4	
ADG, lb	3.24	2.97	2.87	0.183
F/G	4.77	5.2	5.5	0.349
Day 1-55				
BW (day 55), lb[e]	802	808	802	2.93
DMI, lb	14.7	14.7	14.7	
ADG, lb	2.56	2.67	2.52	0.069
F/G	5.73	5.52	5.87	0.165

[ab]Means within a row with different superscripts are different ($P < 0.05$).

[cd]Means within a row with different superscripts are different ($P < 0.10$);

[e]4% shrink applied.

Figures

Figure 1. Mean hourly ambient temperature (^{0}F) and wind chill (^{0}F) during the 5 d TT collection period[a]

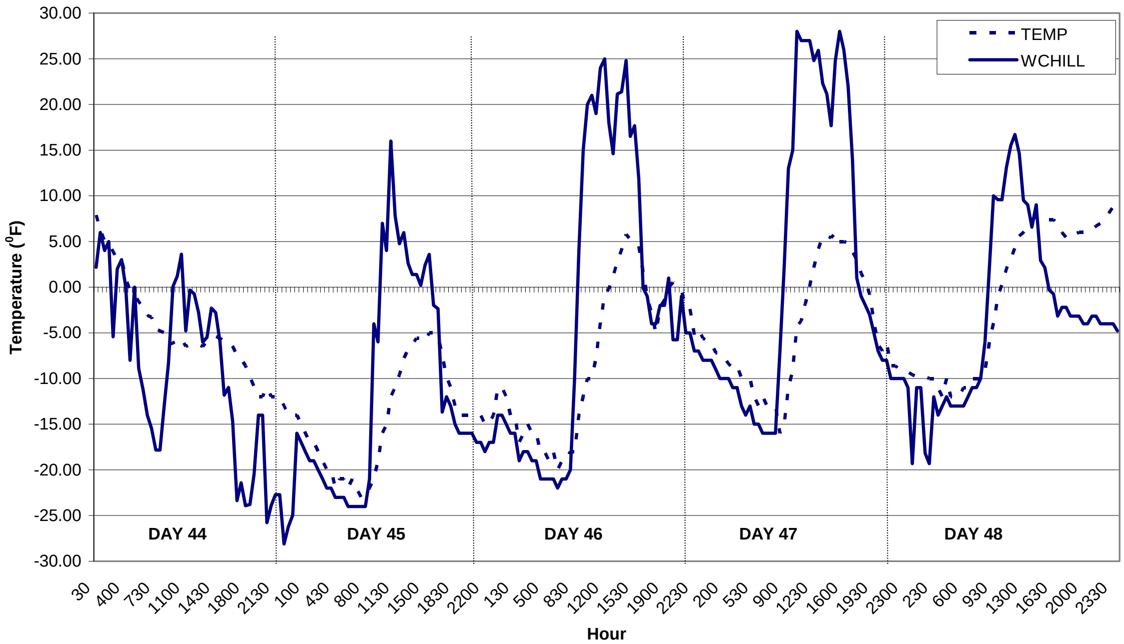

Figure 2. Peak TT during the collection period.