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Effects of Heat Exposure on Adapting Feedlot Cattle to Finishing Diets

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Body temperatures increased in individually fed cattle being stepped-up on finishing diets under both thermoneutral and hot conditions.

Summary

Individually fed feedlot cattle were exposed to excessive heat load (HOT) or thermoneutral (TNL) conditions while being stepped-up to a finishing diet by decreasing roughage from 55 percent to 10 percent in the diet. At 10 percent roughage, heat exposure resulted in reduced metabolizable energy intake (MEI), dry matter intake, and pulse rate. However, over the entire trial, pulse rates tended to be influenced more by MEI than environmental conditions. Data indicate that intakes of individually fed cattle were maintained when 40 and 25 percent roughage diets were fed. However, significant declines in intake were found in cattle stepped-up to 10 percent roughage diets when exposed to increasing levels of excessive heat load.

Introduction

Environmental discomfort in the form of excessive heat load (EHL) can represent a sizeable economic loss to cattle feeders through reduced performance and, in extreme cases, death of feedlot animals. Problems in managing cattle exposed to EHL are further complicated if cattle have to cope with other stressors, such as adaptation to high energy (HE) finishing diets. The objectives of this research were to evaluate cattle exposed to EHL while being stepped-up to HE feedlot diets.

Procedure

A metabolism trial was conducted during late spring and early summer at the University of Queensland, Gatton College, Department of Animal Production facilities. Six *Bos taurus* (Hereford) steers were randomly assigned to individual stalls (9.8 ft x 3.3 ft). The metabolism unit had been divided into two separate rooms, each containing

Table 1. Composition of diets.

	Period			
	Pre-trial	1	2	3
Ingredient, % of DM				
Barley	21.0	27.5	35.0	42.5
Sorghum	21.0	27.5	35.0	42.5
Alfalfa hay	11.0	—	5.0	10.0
Oat hay	44.0	40.0	20.0	—
Supplement[a]	3.0	5.0	5.0	5.0
Calculated nutrient content, % of DM				
Dry matter	90.0	90.0	90.0	90.0
Crude protein	13.5	13.4	13.4	13.4
Calcium	.55	.57	.60	.63
Phosphorous	.34	.39	.42	.44
Roughage	55.0	40.0	25.0	10.0
Rumensin, g/ton	15.0	25.0	25.0	25.0
NEg, mcal/cwt	43.6	48.6	54.5	60.5

[a]Fed in dry form and contained protein, minerals, vitamins, and Rumensin.

Table 2. Mean climatic conditions and temperature-humidity index (THI) associated with feedlot cattle fed adaptation diets and exposed to thermoneutral (TNL) or hot (HOT) environments.

Environment:	TNL				HOT			
Diet period[a]:	1	2	3	Mean	1	2	3	Mean
Temperature, °F	76.1	78.1	82.6	79.3	85.3	87.1	92.1	88.7
Relative humidity, %	65.3	69.5	65.9	66.8	52.1	51.4	46.4	49.5
THI	72.6	74.6	77.9	75.4	77.8	79.0	81.8	79.7

[a]Diets fed in periods 1, 2, and 3 contained 40, 25, and 10% roughage, DM basis, and were fed sequentially 5, 5, and 7 days, respectively.

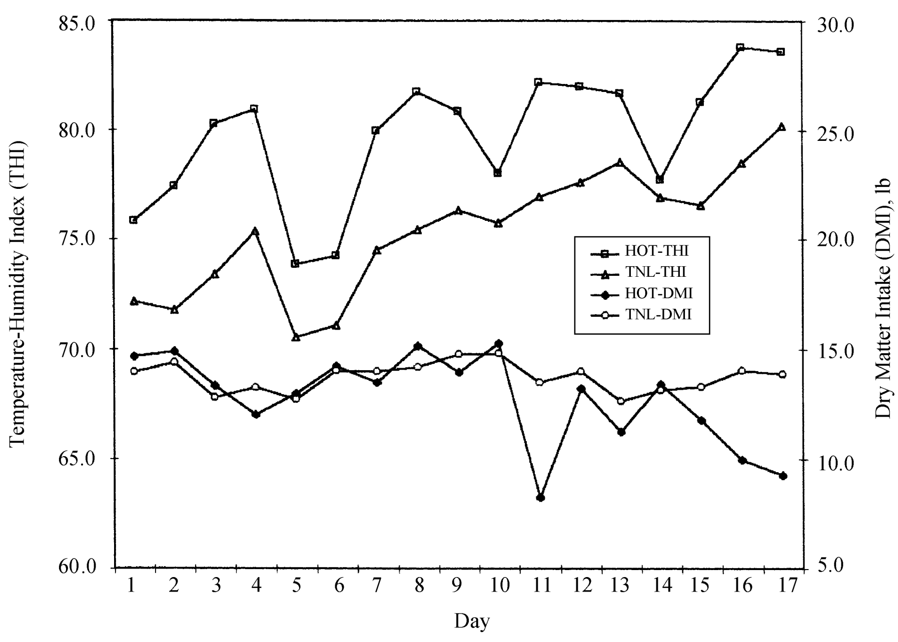

Figure 1. THI and DMI for cattle fed 40% roughage diet (day 1-5), 25% roughage diet (day 6-10), and 10% roughage (day 11-17) when exposed to thermoneutral (TNL) or hot (HOT) environmental conditions.

three stalls. The rooms were separated by an insulated partition. One room had the capability of being heated to temperatures above 100°F (HOT) while the other room could be maintained at or near thermoneutral (TNL) conditions.

Before entering stalls, steers (mean weight = 527 lb) were accustomed to tying over a 30-day period. Steers were brought into stalls and fed a 55 percent roughage diet (Table 1) 10 days before trial initiation. During the trial, steers were fed 40, 25, and 10 percent roughage diets for 5, 5, and 7 days, respectively, over a 17-day period. During that time, the HOT group of steers was exposed to EHL by heating the HOT room from approximately 72°F beginning at 1000 hr, to temperatures around 100°F between 1400 and 1900 hr. Although test room temperature treatments were imposed during the day, room temperatures were also influenced by and varied with outside conditions, particularly at night. A gradual cooldown to TNL conditions was allowed at night to depict normal cyclical daily temperatures. Over the entire study, the TNL room peak temperature averaged 82.4°F during the afternoon, and tended to also follow a natural cyclical temperature pattern.

Steers were fed once daily in the morning. Feed intake (DMI) and metabolizable energy intake (MEI) were determined daily for each steer. Respiratory rate (RR) and pulse rate (PR) were measured daily at 1600 hr on each steer. Body temperature (BT) was obtained via an 8-inch rectal probe with a thermistor mounted in the tip; BT were taken at ten-minute intervals for the duration of the trial using a data logger. Pulse rate was determined via a pulse monitor attached to an ear clip sensor. A baseline PR was determined for each steer by averaging six readings taken over the last four days of the pre-trial period while the steers were on the 55 percent roughage diet.

Results

As a result of changing outside ambient temperatures, mean temperatures (Table 2 and Figure 1) were not able to be maintained throughout the trial, but

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Table 3. Mean dry matter intake (DMI), metabolizable energy intake (MEI), respiratory rate (RR), pulse rate (PR), change from baseline PR (PRCHG), and body temperature (BT) for feedlot cattle fed adaptation diets and exposed to thermoneutral (TNL) or hot (HOT) environmental conditions (ENVCON)[a].

Diet period:	1		2		3	
ENVCON:	TNL	HOT	TNL	HOT	TNL	HOT
DMI, lb/day	13.43^{c}	13.56^{c}	14.33^{d}	14.40^{d}	13.47^{c}	11.00^{b}
MEI, mcal/day	15.98^{c}	16.14^{c}	18.11^{d}	18.20^{d}	18.05^{d}	14.74^{b}
RR, breaths/min	58^{b}	109^{d}	64^{b}	132^{e}	80^{c}	135^{e}
PR, beats/min	87^{b}	92^{bc}	96^{cd}	93^{b}	102^{d}	86^{b}
PRCHG, %	2.9^{b}	8.4^{bc}	12.0^{cd}	10.2^{bcd}	18.2^{d}	2.7^{b}
BT, °F	103.3^{b}	103.3^{b}	103.8^{bc}	104.5^{cd}	104.7^{d}	105.6^{e}

[a]Diets contained 40, 25, and 10% roughage and were fed sequentially for 5, 5, and 7 day periods, respectively.

[bcde]Means in a row with different superscripts differ ($P < .05$).

increased from period one to period three in both TNL and HOT rooms by 6.5 F° and 6.8 F°, respectively. Mean temperature humidity index (THI) was 4.3 (75.4 vs 79.7) units greater in the HOT room. Peak THI averaged 72.4, 75.2, and 79.6 in the TNL room and 83.8, 84.7, and 88.1 in the HOT room in periods 1, 2, and 3, respectively.

During periods 1 and 2 (Table 3 and Figure 1), when steers were fed 40 percent and 25 percent roughage diets, respectively, DMI and MEI were unaffected by EHL. When the 10 percent roughage diet was fed (period 3), DMI and MEI were decreased significantly ($P < .05$) for the steer group in the HOT room even though steers were exposed to EHL for 10 days previously. Respiratory rates increased (periods 1 vs 3) with increases in energy density of the diet fed in both TNL and HOT treatments. However, PR increased only in the TNL treatment; the lowest PR occurred in the HOT treatment when DMI and MEI were the lowest (period 3). Percent change, from a baseline PR, followed a similar pattern. In the TNL treatment, PR tended to increase with each increase in energy density of the diet, while in the HOT treatment, PR tended to be indicative of MEI. As steers moved from lower to higher energy density diets, BT significantly ($P < .05$) increased in both TNL and HOT treatments. As expected, the greatest increase in BT occurred in the HOT treatment. The inability of an animal to dissipate or rapidly acclimate to added heat from the diet most likely contributed to the decline in DMI for cattle fed the 10 percent roughage diet in the HOT treatment.

Pre-trial baseline temperatures, while cattle were fed the 55 percent roughage diet in the stalls, averaged 102.3°F for both HOT and TNL treatments. Normal rectal BT, for the cattle type used, should average 101.5 ±1°F. During the trial, average steer BT ranged between 103.3 to 105.6°F. There was no evidence of ill health in the steers during the trial; intakes (DMI) remained between 2.1 and 2.7 percent of body weight. The increase in ambient temperatures of < .5 F°/day, on the average, during the trial may have also contributed to an

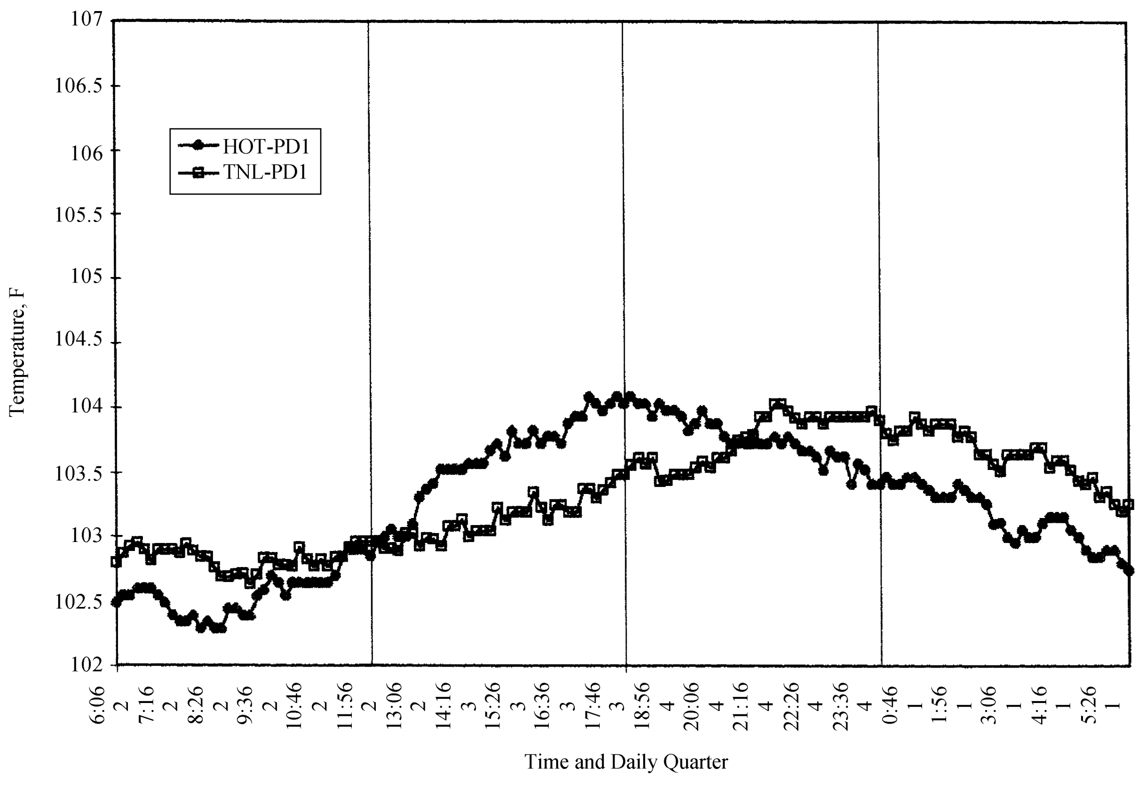

Figure 2. Rectal temperatures for steers fed 40% roughage diet (period 1-day 1 through 5).

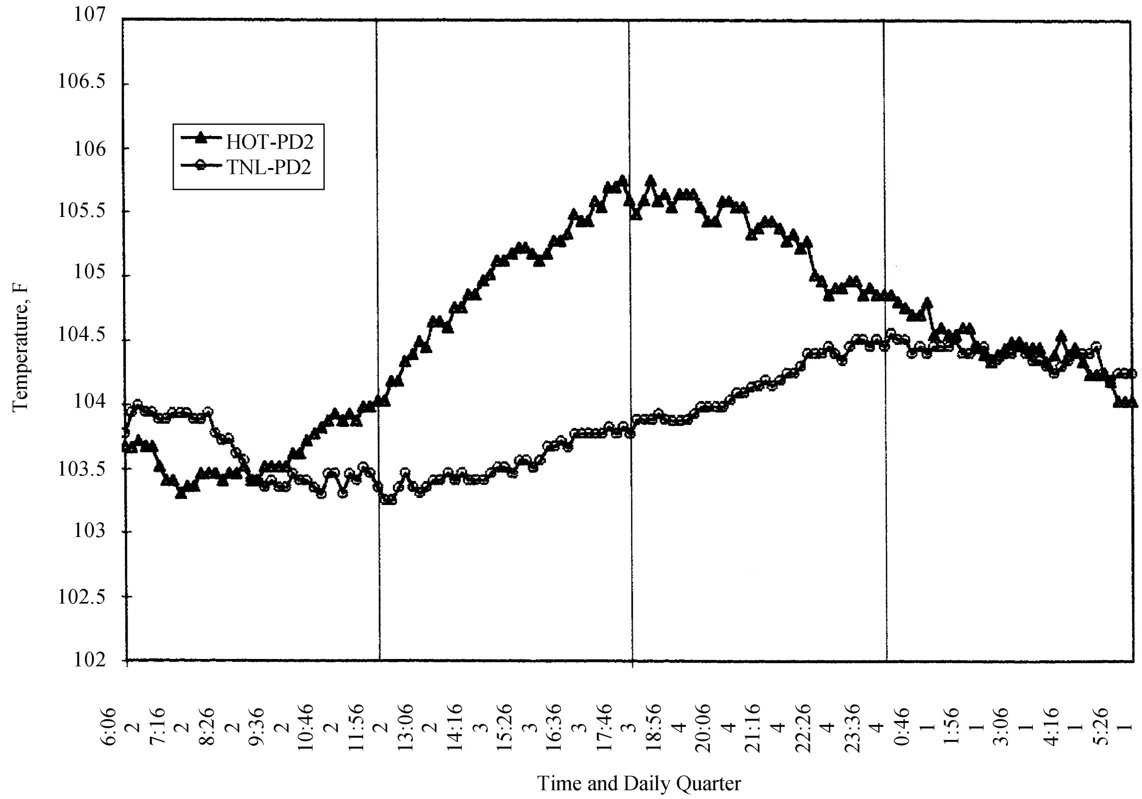

Figure 3. Rectal temperatures for steers fed 25% roughage diet (period 2-day 6 through 10).

increase in BT; although this gradual change in normal ambient temperature should have minimal effect on BT. Increasing dietary energy density, by decreasing roughage level from 55 percent to 10 percent, increased BT over 2 F° (102.3 vs 104.7) in the TNL treatment. The higher roughage diets (≥25% of diet DM) are lower in metabolizable energy density, appear to contribute less to metabolic heat load, and thus appear to allow for lower peak BT. Once cattle are adapted to high energy diets, the extent to which BT returns to previous normal BT is not known. Feeding higher energy diets would appear to make cattle more susceptible to EHL, particularly as they are being stepped-up or adapted to high energy diets.

Figures 2 through 4 display the 24-hr BT pattern associated with cattle exposed to EHL and fed 40 percent, 25 percent and 10 percent roughage diets, respectively. Although THI was similar between periods 1 and 2, dramatic differences are apparent in the relative shape of the BT curves. Ranges and magnitude in BT were similar between TNL and HOT treatments when a 40 percent roughage diet was fed (Figure 2). When 25 percent (Figure 3) and 10 percent (Figure 4) roughage diets were fed, differences ($P < .05$) in maximum and minimum BT were observed between HOT and TNL treatments from 1201 to 1800 hr and 1801 to 2400 hr. Although ranges in BT increased as higher energy density diets were consumed, differences in BT range were not found between TNL and HOT treatments.

The four quarterly periods for the HOT treatment roughly correspond to a transition period (Quarter 2) from nighttime cool-down to day heating, increased BT period associated with heat stress (Quarter 3), transition from daytime heat to nighttime cool-down (Quarter 4), and nighttime cooling (Quarter 1). For the TNL treatment, the periods are similar except Quarter 3 and 4 both represent an increase in BT with no transition prior to nighttime cooling being present. In all feeding periods, lower or nearly equal BT (Quarter 1) were found in the HOT treatment during the initial portion of nighttime cooling compared to the TNL treatment. This may be a result of the overcompensation of physiologic and metabolic processes associated with reducing BT as opposed to the TNL treatment, in which BT during nighttime cooling tended to remain stable from midnight then drop-off beginning around 400 hr, particularly for steers fed 25 percent and 10 percent roughage diets.

In the TNL treatment, continued metabolism of ingested feed, at a time when the steers are lying down (reducing surface area exposure and dissipation of heat), possibly explains the slight rise in or maintenance of BT after midnight. As digestion of ingested feed diminishes, when the animal rises and exposes more body surface area to dissipate heat, and/or environmental temperatures decline, BT begins to decline during the latter part of period 1. For the TNL treatment, BT tended to remain at a low point until mid to late morning (Quarter 2), or approximately 2 to 4 hr post-consumption of the AM feed

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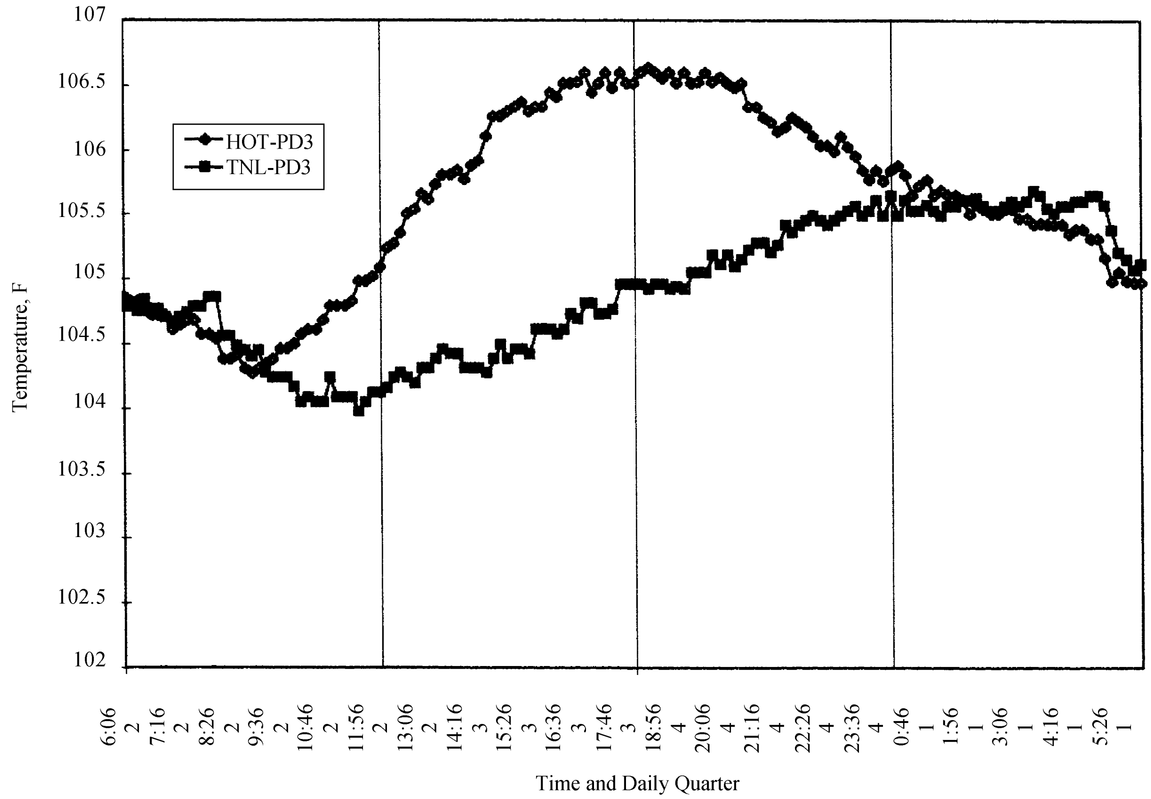

Figure 4. Rectal temperatures for steers fed 10% roughage diet (period 3-day 11 through 17).

(Figures 3 and 4). Also, BT of the HOT treatment group was found to be as low or lower than BT of the TNL treatment group during some portion of quarter 2 in both periods 1 and 2 (figures 2 and 3). This drop in BT in the HOT group to equivalent BT levels was not found in period 3 (figure 4). Obtaining BT levels in quarter 2, which are comparable to those in cattle fed under TNL conditions, may be needed for normal DMI to be obtained in cattle exposed to excessive heat load.

In conclusion, feedlot cattle (individually fed in metabolism units) being adapted from 55 percent to 10 percent roughage diets and exposed to EHL were able to maintain intake up to the 25 percent roughage diet, even though BT was elevated from the heat load. At 10 percent roughage, effects of increased dietary energy density in combination with EHL were sufficient to reduce DMI and MEI. Increases in BT were found in cattle as they were stepped up from 40 to 10 percent roughage diets under both TNL and HOT conditions.

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