Effects of Feeding Level and Diet Energy Density on Cattle Exposed to Heat

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Under hot environmental conditions, individually fed steers maintained lower body temperatures and greater intakes when limit fed when compared to steers fed the same diet ad libitum.

Summary

Individually-fed feedlot steers were exposed to excessive heat load or thermoneutral conditions and fed a 6% roughage diet (135 ME, Mcal/cwt) ad libitum (HE) or the same diet 90% of ad libitum (LE), or fed a 28% roughage diet (124 ME, Mcal/cwt) ad libitum (HR). Steers fed HE diets had greater (P < .10) respiratory rates than cattle fed HR diets. Also, HE fed cattle had greater (P < .10) pulse rate than LE and HR fed cattle at 0 800 hr but not at 1600 hr. Near the time of peak heat exposure (1600 hr), under hot conditions, HE and LE fed steers had body temperatures 1.5 and 1.0 F° greater (P < .10) than HR fed cattle, although metabolizable energy intake tended to be greater for LE fed steers and lower for HR fed steers when compared to HE fed steers.

Introduction

Factors such as high solar radiation, high air temperature, high humidity, and low wind velocity are conditions that can lead to animal discomfort and lower performance. Although proper feedlot design partially alleviates problems associated with excessive heat load (EHL), it cannot eliminate effects. Management of diet and feeding programs to aid in alleviating problems of EHL may become more crucial during periods of environmental stress. This study was undertaken to evaluate individually-fed feedlot cattle provided diets having different dietary energy levels and densities when subjected to thermoneutral or hot environmental conditions.

Materials and Methods

A metabolism trial was conducted during the late summer and early autumn at the University of Queensland, Gatton College, Department of Animal Production facilities. Six yearling Hereford steers (mean weight = 780 lb) were randomly assigned to individual stalls (9.8 ft × 3.3 ft) in one of two temperature controlled rooms. Each animal was restrained in its stall by a head halter and had previously been accustomed to being led and tied. Three diet treatments were imposed (Table 1). Cattle were fed a 6% roughage diet ad libitum (HE) or the same diet at 90% of ad libitum (LE), or fed ad libitum a 28% roughage diet (HR) such that ME intake of the 28% roughage diet approximated the ME intake of the restricted-fed 6% roughage diet. Water was available ad-libitum. The trial was replicated three times with steers being assigned to a different feeding regime and environmental condition combination each period.

Table 1. Composition of diets.

	Roughage level	
	28%	6%
Ingredient, % of DM		
Barley	34.0	44.8
Sorghum	34.0	44.8
Alfalfa hay	19.0	6.0
Barley straw	9.0	—
Limestone	—	.4
Dry supplement[a]	4.0	4.0
Calculated nutrient content, % of DM		
Dry matter	90.0	90.0
Crude protein	12.8	12.8
Calcium	.69	.64
Phosphorus	.38	.43
Rumensin, g/ton	20.0	20.0
NEg, Mcal/lb	.53	.62
ME, Mcal/lb	1.24	1.35

[a]Contained protein, minerals, vitamins and Rumensin.

Steers were accustomed to feeding treatment over a seven-day period at or near thermoneutral conditions. Feed intakes and refusals were recorded daily throughout the trial. During the test periods (four days each), the hot room was heated to temperatures in excess of 100°F through supplementary heat while temperatures in the thermo neutral room ranged from 62.8°F to

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83.9°F. The test rooms varied in temperature with outside conditions, particularly at night. High temperatures were imposed in the hot room beginning at 1000 hr and ending at 1800 hr. A gradual cool-down to thermoneutral conditions was allowed at night to depict normal cyclical daily temperatures. Temperature in the thermoneutral room was also allowed to follow a normal cyclical pattern.

Feed dry matter intake (DMI) and metabolizable energy intake (MEI) were determined daily for each steer. During the four-day test periods, respiratory rate (RR) and pulse rate (PR) were measured daily at 0800 and 1600 hr on each steer; body temperature (BT) was recorded, using a data logger, at five minute intervals for the duration of the trial via an 8-inch rectal probe with a thermistor mounted in the tip. Pulse rate was determined via a pulse monitor attached to an ear clip sensor.

Data were analyzed for a 2 x 3 factorial design with pre-planned comparisons made for HE vs LE diets, HE vs HR diets, environmental treatment by HE and HR diet interaction, and environmental treatment by HE and LE diet interactions.

Results

Mean temperature in the thermoneutral room (Table 2), over the test period, averaged 74.4°F. Relative humidity (RH) ranged from 39.8% to 94.3% (mean 68.4%). Mean temperature-humidity index (THI) was 71.7 and ranged from 61.5 to 81.0. Mean temperature in the hot room was 86.5°F and ranged from a maximum of 105.3°F to a minimum of 60.1°F. Mean RH was 56.0% and ranged from 13.4 to 93.7%. Mean THI was 79.1 and ranged from 59.6 to 92.1. Mean THI between 1200 and 1800 hr was 85.4 in the hot room and 71.0 in the TNL room. During this time period, temperature in the hot room averaged 98.4°F.

Mean RR (Table 3) was greater ($P < .10$) for cattle in the hot room at both 0800 and 1600 hr. Cattle fed HE diets had greater ($P < .10$) RR than LE fed cattle at 0800 hr only but greater RR than HR fed cattle at both 0800 and 1600 hr. Only at 0800 hr did PR differ; HE fed cattle had greater ($P < .10$) PR than LE and HR fed cattle. Interactions between environmental conditions and diet existed for BT at both times. Near the time of peak heat exposure (1600 hr), HE and LE fed cattle had BT 1.5 and 1.0 F° greater, respectively, than HR fed cattle. Under thermoneutral conditions, BT tended to be similar among diet treatments but with the LE fed steers tending to have the lowest BT. Under hot conditions, BT were greatest for HE fed cattle and the least for HR fed cattle (Table 3, Figure 1, and Figure 2).

In the thermoneutral treatment group (Table 4), DMI of the LE fed steers was 91.5% of that for the HE fed steers and near the designed level of 90%. Environmental condition by diet interactions ($P < .10$) were found for DMI, MEI and mean daily water intake (WTI). In both environmental treatment groups, DMI as a percent of bodyweight (% BW) was similar for HE and HR fed steers. However, LE steers tended to have the lowest DMI under thermoneutral conditions, but tended to have the greatest DMI under hot conditions. This same trend was particularly evident for MEI and MEI (% BW) under hot conditions; whereas under thermoneutral conditions, MEI was similar between LE and HR fed steers but greater than HE fed steers. Under hot conditions, DMI as a % of BW were reduced by a similar amount (.33 units) for the ad libitum fed steer groups (HE and HR) when compared to steers fed under thermoneutral conditions. Lower DMI and MEI found in the HR fed steers would most likely contribute to the lower BT experienced in steers fed under hot conditions, although lower BT was not found for HE fed steers with the reduced intakes experienced under hot conditions.

Water intake was greater ($P < .10$) for LE and HR fed steers when com-

Table 2. Mean environmental conditions associated with feedlot cattle exposed to thermoneutral (TNL) or hot (HOT) environments[a].

Environment:	TNL	HOT
Temperature, F°	74.4	86.5
Relative humidity, %	68.4	56.0
THI	71.7	79.1

[a]Cattle were fed ad libitum (HE) or 90% of ad libitum (LE) a 6% roughage diet, or fed ad libitum a 28% roughage diet (HR) such that ME intake of the 28% roughage diet approximated the ME intake of the restricted-fed 6% roughage diet.

Table 3. Mean respiratory rate (RR), pulse rate (PR), and body temperature (BT) collected at 800 and 1600 hr for cattle fed feedlot diets while being exposed to thermoneutral or hot environmental conditions (Env)[a].

Env:	TNL			HOT		
Diet:	HE	LE	HR	HE	LE	HR
RR, breaths/min						
800 hr[b,c,d,e]	60.9	55.6	56.1	66.4	59.5	60.9
1600 hr[b,c,e]	74.7	70.5	61.3	128.0	125.4	122.7
PR, beats/min						
800 hr[c,d,e]	80.7	77.1	76.2	79.2	75.7	72.4
1600 hr	92.9	92.2	88.7	85.7	93.0	86.8
BT, F[1]						
800 hr[b,c,d,e,f,g,h]	101.6	101.4	101.5	103.1	102.0	101.7
1600 hr[b,c,d,e,f,g,h]	102.1	101.5	102.0	105.0	104.5	103.5

[a]Cattle were fed ad libitum (HE) or 90% of ad libitum (LE) a 6% roughage diet, or fed ad libitum a 28% roughage diet (HR) such that ME intake of the 28% roughage diet approximated the ME intake of the restricted-fed 6% roughage diet.
[b]Env effect ($P < .10$).
[c]Diet effect ($P < .10$).
[d]HE vs LE ($P < .10$).
[e]HE vs HR ($P < .10$).
[f]Env by diet interaction ($P < .10$).
[g]Env by HE and LE interaction ($P < .10$).
[h]Env by HE and HR interaction ($P < .10$).

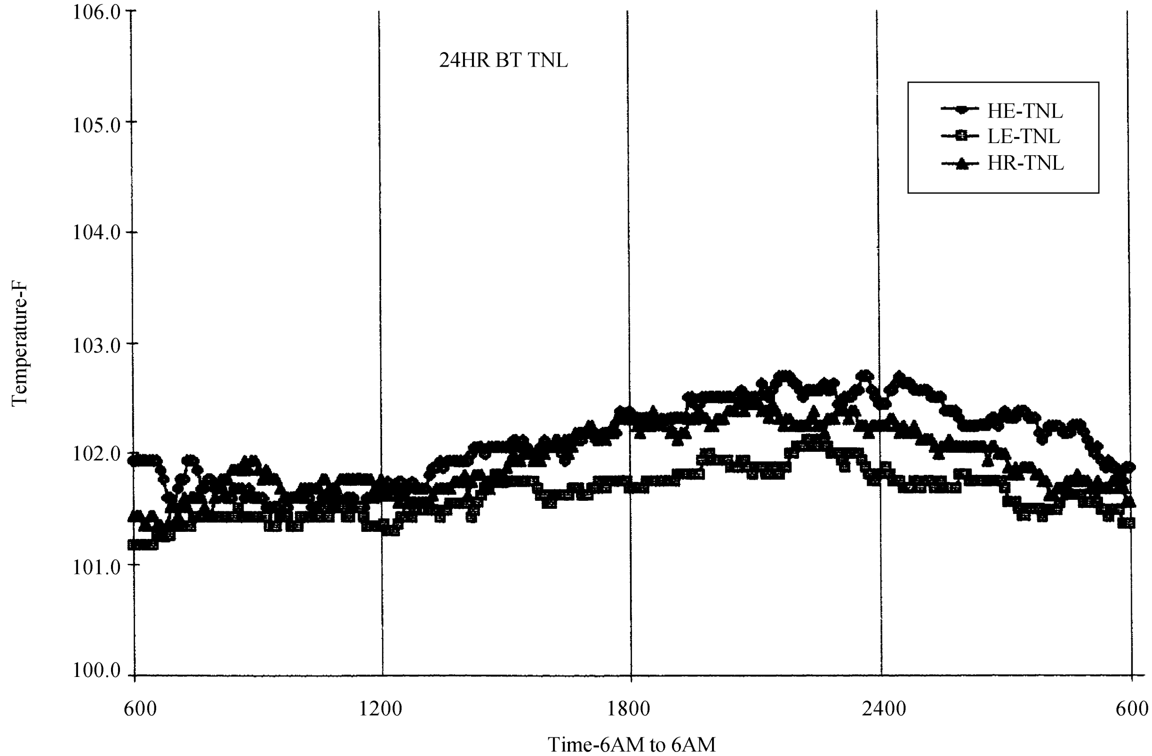

Figure 1. Rectal temperatures for steers fed a high energy diet, ad libitum (HE) or limited (LE), or fed 28% roughage diet (HR) under thermoneutral conditions.

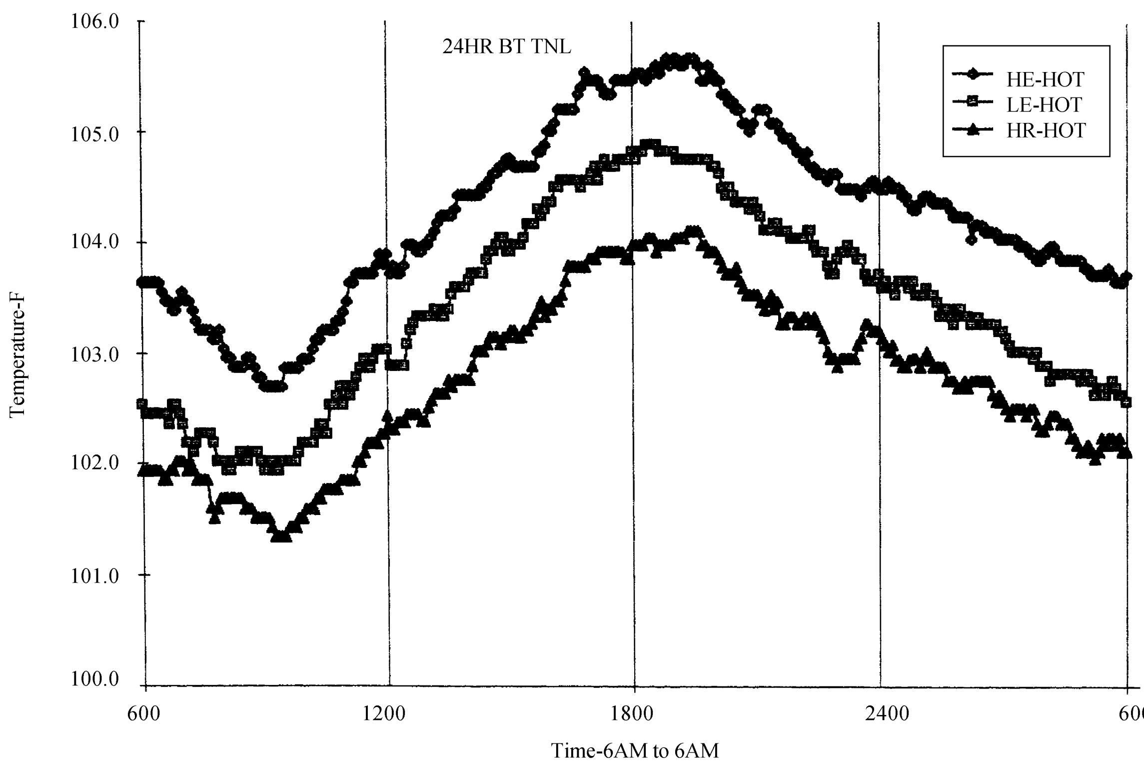

Figure 2. Rectal temperatures for steers fed a high energy diet, ad libitum (HE) or limited (LE), or fed 28% roughage diet (HR) under hot environmental conditions.

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Table 4. Mean daily dry matter (DMI), metabolizable energy (MEI), and water intake (WTI) for cattle fed feedlot diets and exposed to thermoneutral or hot environmental conditions (Env)[a].

Env:	TNL			HOT		
Diet:	HE	LE	HR	HE	LE	HR
DMI, lb/day[b,c,d]	15.71	14.37	15.82	13.36	13.71	12.97
MEI, Mcal/day[b,c,d,e,f,g]	21.30	19.47	19.56	18.11	18.58	16.03
DMI, % BW[b,c,d]	2.00	1.80	1.99	1.67	1.75	1.67
MEI, % BW[b,c,d,e,f,g]	5.98	5.38	5.42	4.99	5.23	4.55
WTI,						
gal[e,f,g]	5.88	7.05	7.10	5.41	7.49	6.83
gal/lb DMI[b,c,e,f,g,h]	.38	.47	.43	.38	.54	.53
gal/Mcal MEI[b,c,e,f,g,h]	.28	.35	.35	.28	.40	.43

[a]Cattle were fed ad libitum (HE) or 90% of ad libitum (LE) a 6% roughage diet, or fed ad libitum a 28% roughage diet (HR) such that ME intake of the 28% roughage diet approximated the ME intake of the restricted-fed 6% roughage diet.
[b]Env effect ($P < .10$).
[c]Env by diet interaction ($P < .10$).
[d]Env by HE and LE diet interaction, ($P < .10$).
[e]Diet effect ($P < .10$).
[f]HE vs HR ($P < .10$).
[g]HE vs LE ($P < .10$).
[h]Env by HE and HR diet interaction ($P < .10$).

pared to HE fed steers; only in the LE fed group did hot conditions enhance WTI, although the interactions between environmental conditions and diet were not found. Expressing WTI per unit of DMI and MEI showed similar trends although environmental conditions by diet (HE vs HR) interactions existed ($P < .10$). Cattle fed HR diets tended to consume more water per lb of DMI and mcal of MEI under hot conditions; effects of hot conditions were not found for HE fed cattle. Data suggest that under hot conditions, LE and HR individually-fed cattle had lower BT than HE fed cattle and that DMI of LE fed cattle was reduced slightly but remained above DMI of HE and HR fed cattle.

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