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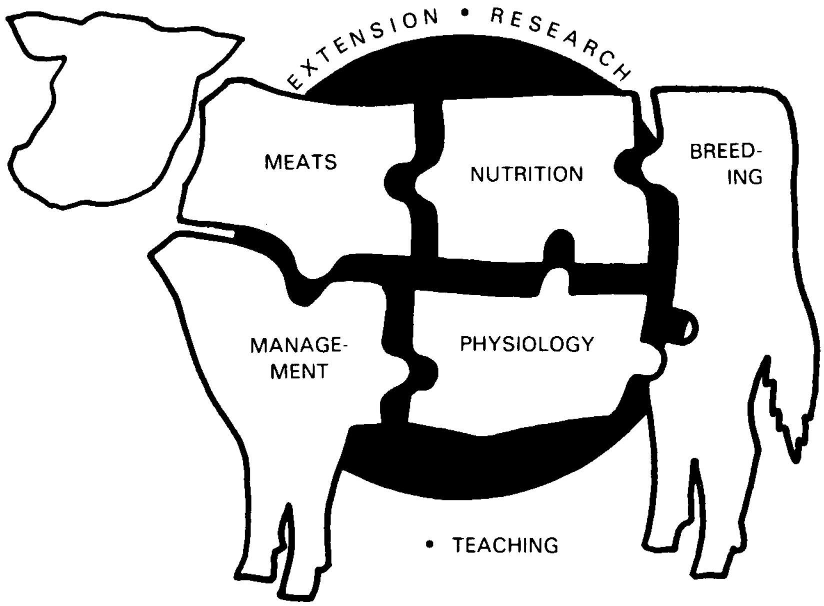

Beef Cattle Report

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CON treatment compared to the two levels of beet pulp (P < .05). No differences between treatments for ribeye area or yield grade were found. Quality grades were analyzed by chi-square distribution. The percent grading Choice or above varied by treatment (P = .09).

Feed conversions between the corn silage and beet pulp diets were similar. There was a difference in DMI between the CON and beet pulp treatments, although when the two levels of beet pulp were compared, they were not different. Beet pulp can serve as a replacement for corn silage in finishing diets and it has a similar feeding value. In this experiment, dry matter intake was slightly affected, however feed efficiency was not different when beet pulp was fed. These results agree with those reported in the 1993 Nebraska Beef Report (pp. 48-49) where daily gains and feed conversions were not different when 10% corn silage was replaced with 10% beet pulp on a DM basis in a finishing diet.

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Effects of Feeding Regimen on Performance, Behavior and Body Temperature of Feedlot Steers

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Changing feeding regimen of feedlot animals during potential heat stress periods can effectively lower body temperature, thus decreasing the risk of possible heat related production losses.

Summary

One hundred forty-four predominantly Angus x Charolais steers were used to determine effects of different feeding regimens on performance, behavior and tympanic temperatures of steers under environmental heat stress. Steers were assigned to one of three treatments: 1) ad libitum fed at 0800 hr (ADLIB); 2) fed at 1600 hr with bunks slick by 0800 hr (BKMGT); and 3) fed 85% of predicted DMI at 1600 hr (LIMFD). Treatments were imposed for 23 days after which all steers were allowed ad libitum access to feed at 0800 hr. Overall performance was not affected by treatment. Altering feed time and amount reduced tympanic temperature and altered eating pattern.

Introduction

Daily feed intake contributes to the metabolic heat load of animals. When animals are presented with adverse climatic conditions consisting of elevated ambient temperature, relative humidity, and solar radiation, they may be unable to effectively dissipate metabolic heat load. Altering feeding regimen during times of potential heat stress may be beneficial in maintaining overall performance.

Possible strategies for altering the timing or reducing the peak metabolic heat load include adjusting the time of feed consumption and limit-feeding, respectively. Research has shown limit-feeding may reduce metabolic rate and improve overall efficiency when cattle are subsequently provided ad libitum access to feed. The objectives of our study were to determine effects of altered feeding regimen on performance and changes in eating behavior of feedlot steers during potential heat stress periods. Additionally, tympanic temperatures of the steers were monitored under both thermoneutral and hot environmental conditions to determine alterations in body temperature in response to altered feeding regimen.

Procedure

One-hundred forty-four Angus x Charolais steers were used. Upon initiation of the trial steers were implanted with Synovex-Plus® with average body weight on two consecutive days serving as initial weight. Steers were blocked by color (black or white) and randomly assigned to one of 24 pens. All steers were fed a 65 Mcal/cwt NEg ration consisting of (DM basis): 84% dry rolled corn, 7.5% alfalfa hay, 4.5% liquid supplement, 2% soybean meal and 2% dry supplement. Treatments were assigned to pens and consisted of: 1) ad libitum feeding at 0800 hr (ADLIB); 2) bunk management, feed delivered at 1600 h and managed to be empty by 0800 hr (BKMGT); and 3) limit-fed, delivered 85% of predicted DMI at 1600 hr (LIMFD). Treatments were initiated on day 0 (June 23, 1999) and imposed for 23 days (managed feeding phase), then all animals were allowed *ad libitum* access to feed delivered at 0800 hr.

Daily feed and water intakes were recorded. Body weights were obtained on days 23 and at the termination of the trial (day 82; Sept. 13, 1999). On day 83 steers were transported to a commercial slaughter facility. Hot carcass weight, fat thickness, marbling score, and yield

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grade were obtained.

An automated weather station, located in the center of the facility, compiled minute by minute monitoring of temperature (Ta), relative humidity (RH), black globe temperature (BGT), wind speed and wind direction into hourly observations. Temperature humidity and black globe-humidity indices (THI and BGTHI, respectively) were calculated hourly using the weather station data to characterize the climatic heat load experienced by the animals. The THI equation is defined as:

$$THI = Ta - (.55 - (.55 * (RH/100))) * (Ta - 58)$$

The BGTHI is determined by substituting BGT for Ta in the equation. Black globe is more comprehensive in its evaluation of weather conditions because it incorporates the effects of wind speed and solar radiation along with temperature.

Behavioral observations were made at 0900, 1300, 1700 and 2100 hr on various days throughout the trial and included assessments of panting and feed available in the bunk. Panting scores were assigned to each animal and consisted of the following: 0 = normal breathing; 1 = slightly elevated respiration rate; and 2 = excessive panting accompanied by salivation. Bunk scores were assigned on a pen basis and consisted of the following: 0 ≤ 10% of the days feed amount left in bunk; 1 = 10 – 50% of the days feed remaining; and 2 ≥ 50% of the days feed remaining in the bunk. Upon termination of the trial, data were grouped according to climatic conditions (thermoneutral vs. hot) and feeding phase (managed vs. *ad libitum*). This resulted in five distinct periods consisting of: 1) MTNL 1; thermoneutral conditions (THI < 74) during the managed feeding period, days 9 and 13; 2) MHOT 1; hot environmental conditions (THI > 75) during the managed feeding period, days 11 and 12; 3) MTNL 2; thermoneutral conditions (THI < 74) during the managed feeding period, days 14 and 15; 4) MHOT 2; a second episode of hot environmental conditions (THI > 75) during the managed feeding period, days 21 and 22; and 5) AHOT; hot environmental conditions (THI > 75) during the *ad libitum* period (days 35 and 36)

Tympanic temperature (TT), an indicator of body temperature, was determined using 24 animals on days 9 - 22 (managed feeding) and 35 – 41 (*ad libitum*). The same animals were used during each period. Within each pen, loggers were placed in one white and one black animal in order to determine if coat color contributes to heat stress. Temperatures were collected hourly via thermistor leads placed in the ear canal at an approximate depth of 6". At this depth the lead was very near the tympanic membrane of the steers. Thermistor leads were attached to Stowaway® XTI data loggers which were secured in the ear using padded gauze. Data were grouped into three-day periods, which overlapped the two-day MHOT 1, MTNL 2, MHOT 2 and AHOT behavioral periods.

Performance and carcass data were analyzed using GLM procedures of SAS with treatment (TRT) and replication included in the model while behavioral assessments were analyzed by Chi-square analysis. Tympanic temperatures were analyzed using repeated measures ANOVA within TRT, animal, coat color and animal(TRT) in the model.

Results

Performance of the steers during the trial is presented in Table 1. Limit-fed steers had lower (P < .05) BW, DMI, and ADG than BKMGT and ADLIB steers during the managed feeding period (days 0-23). Following *ad libitum* feeding of all cattle, LIMFD steers compensated for their reduced growth during the managed feeding period with 26.0 and 23.1% higher (P < .05) ADG than both ADLIB and BKMGT steers, respectively, and 7.5% higher (P < .05) DMI than ADLIB steers. Limit-fed cattle were 14.7% more efficient following ad libitum feeding than BKMGT steers and tended (P < .10) to be more efficient than ADLIB. Results such as these are common in programmed gain and limit-feeding studies. When overall performance is compared, TRT differences were not significant, suggesting altering feeding regimen for 23 days early in the finishing phase does not impact performance. It is noteworthy that LIMFD cattle tended (P < .10) to consume less water following the managed feeding period than ADLIB and BKMGT steers. The reduction also tended (P < .10) to influence overall water intake in the same

Table 1. Effect of feeding regimen on feedlot performance of yearling steers.

	Treatments[a]			
Item	ADLIB	BKMGT	LIMFD	SEM[b]
Body weight, lb				
Day 0	951.5	955.0	951.3	2.0
Day 23	1055.6[d]	1061.1[d]	1032.9[e]	5.7
Day 82[d]	1229.8	1231.6	1236.0	7.5
Daily gain, lb/day				
Days 0-23	4.51[d]	4.60[d]	3.54[e]	.22
Days 23-82	2.95[d]	2.88[d]	3.63[e]	.11
Days 0-82	3.39	3.37	3.45	.09
Dry matter intake, lb/day				
Days 0-23	21.12[d]	21.10[d]	18.57[e]	.29
Days 23-82	23.34[d]	24.16[ed]	25.10[e]	.48
Days 0-82	21.52	21.93	22.00	.35
Feed:gain				
Days 0-23	4.76	4.72	5.33	.25
Days 24-82	8.02[ed]	8.43[d]	7.35[e]	.26
Days 0-82	6.38	6.50	6.41	.13
Water intake, gal/day				
Days 0-23	8.77	8.85	7.28	.45
Days 23-82	10.87	11.51	9.28	.18
Days 0-82	10.41	10.89	8.61	.23

[a]ADLIB = cattle were allowed access to feed at all times; BKMGT = cattle were fed at 1600 hr with bunks slick at 0800 hr the following day; LIMFD = cattle were fed 85% of their predicted dry matter intake at 1600 hr
[b]Standard error of mean
[c]Day 82 body weight x .96
[de]Values within a row with different superscripts differ (P < .05)

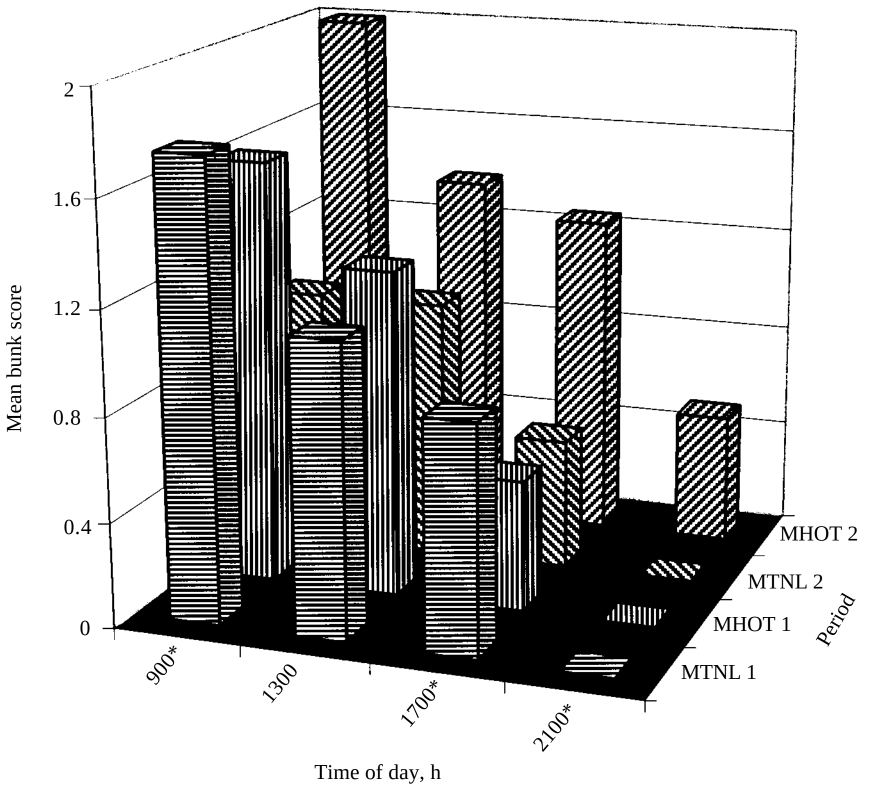

Figure 1. Effect of ad libitum on bunkscores during varying environmental conditions. MTNL 1 = Thermoneutral conditions (days 9 and 13); MHOT 1 = Hot environmental conditions (days 11 - 12); MTNL = Thermoneutral conditions (days 14 - 15); and MHOT 2 = Hot environmental conditions (days 21 - 22). *Bunk scores differ (Chi-square P-value < .05).

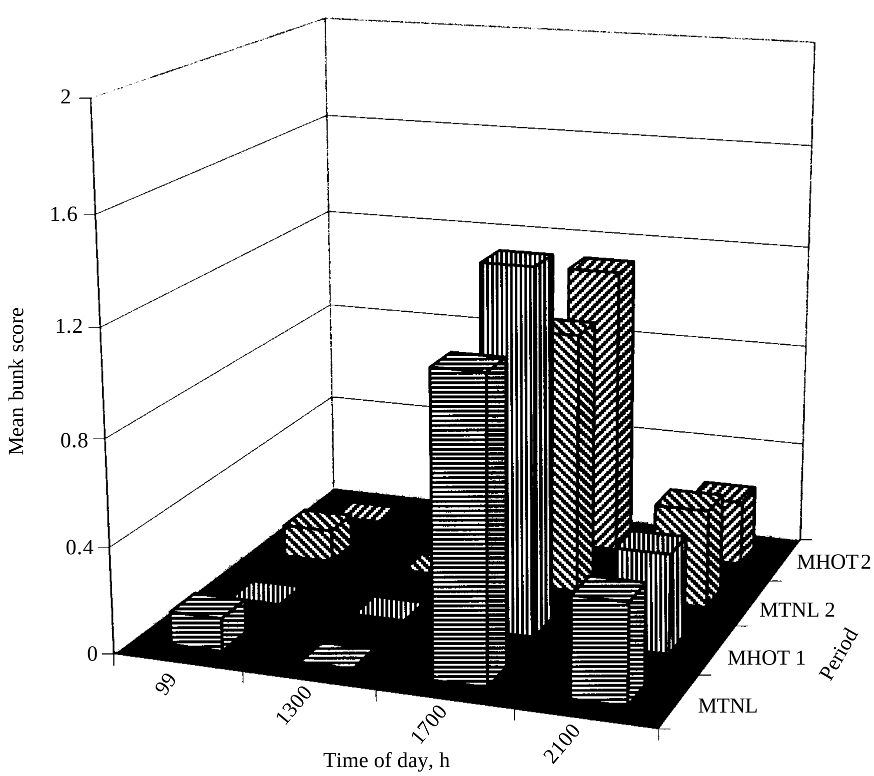

Figure 2. Effect of bunk management feeding on bunkscores during varying environmental conditions. MTNL 1 = Thermoneutral conditions (days 9 and 13); MHOT 1 = Hot environmental conditions (days 11 - 12); MTNL 2 = Thermoneutral conditions (days 14 - 15); and MHOT 2 = Hot environmental conditions (days 21 - 22).

manner. Carcass characteristics did not differ among TRT (data not shown).

Panting scores during TNL periods (MTNL 1 and 2) were not affected by TRT (data not shown). Panting scores were affected by TRT (P < .10) in MHOT 1 (data not shown). At 0900 hr, BKMGT steers had the highest (P < .10) panting score with LIMFD steers being intermediate (.10, .29, and .21 for ADLIB, BKMGT, and LIMFD, respectively). By 1300 hr no differences in panting scores among TRT were observed. However, by 1700 hr BKMGT and ADLIB steers had higher (P < .10) panting scores than LIMFD (.85, .88, and .71 for ADLIB, BKMGT, and LIMFD, respectively). The lower panting scores of LIMFD steers likely are a result of reduced metabolic heat production due to their reduced intake. During the MHOT 2 period, a similar trend in panting scores to MHOT 1 was observed.

Eating behavior of steers on different feeding regimens was characterized with bunk scores being grouped by treatment and analyzed across environmental period. It is generally assumed that cattle will eat a large meal after being fed and then continue to periodically consume smaller meals for the remainder of the day. Environmental conditions alter the feeding patterns of steers such that on hot days, steers will tend to not consume as much feed. At 0900 hr, ADLIB steers had similar bunk scores during the MTNL 1 and MHOT 1 periods (Figure 1). These cattle became more aggressive eaters during MTNL 2 as exemplified by their considerably lower bunk scores at 0900 hr. However, when ambient temperature was elevated a second time (MHOT 2), the steers altered their eating pattern such that they consumed little or no feed at 0900 hr. This shift in intake pattern of these steers during this period resulted in higher bunk scores at 1700 and 2100 hr.

Scores for BKMGT steers are presented in Figure 2. By design, BKMGT steers had no feed in their bunks at the time of the 0900 and 1300 hr observations. Unlike ADLIB steers, steers in this TRT showed no alteration in feed intake pattern associated with environ-

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mental period. Although bunk scores during MHOT 1 and 2 were numerically higher than the TNL periods, differences were not significant (P > .05). This consistent eating pattern suggests that feeding at 1600 hr allowed cattle to maintain a uniform eating pattern under varying environmental conditions. A consistent eating pattern is very important in preventing metabolic disorders sometimes associated with heat stress.

Similar to BKMGT steers, LIMFD steers had no feed at the 0900 and 1300 hr observations (Figure 3). At 1700 hr there was a significant (P < .05) change in bunk scores across environmental period. During MTNL 1, steers consumed a good proportion of their feed within the first hour (1600 – 1700 hr). However, their intake was slowed somewhat during this same time period of MHOT 1. This is likely due to the fact that these animals had already experienced the hottest part of the day and were reluctant to eat a large meal. This, however, was not the case in the MHOT 2 period. In this period, LIMFD steers ate all of their feed within a one-hour period. This aggressive eating behavior occurred despite elevated Ta associated with this period, possibly due to a reduction in the metabolic rate and heat load. Decreases in metabolic rate have routinely been shown in animals experiencing nutritional restriction.

Mean tympanic temperatures of the steers during managed and ad libitum feeding periods are presented in Table 2. There were no TRT effects during MHOT 1. Coat color was significant during this time with black-haired steers having higher (P < .05) TT. By the MTNL 2 period, differences among TRT were significant (P < .05). During this period, BKMGT cattle had lower (P < .05) TT than both ADLIB and LIMFD steers. The lack of a TRT by hour interaction (P > .10) suggests that time of peak heat load was not altered by varying feeding time. However, the magnitude of the peak was lower in BKMGT cattle possibly due to the fact that peak metabolic heat load did not coincide with peak environmental temperature. During MTNL 2 a coat color by time interaction (P < .05) was observed with white-haired steers having lower TT at 1800 (104.4 vs. 103.8,°F) and 1900 (104.5 vs. 103.7,°F) hr. The timing of these differences corresponds to the two to three hour lag typically associated with body temperature in relation to Ta. The higher TT for black-haired steers than for white-haired steers is an indication of the effects solar radiation has on TT. Under peak climatic heat load, maximum TT differences between white and black coat colored steers ranged from .2 to .8°F. Differences in TT due to hair color may be confounded with breed of the

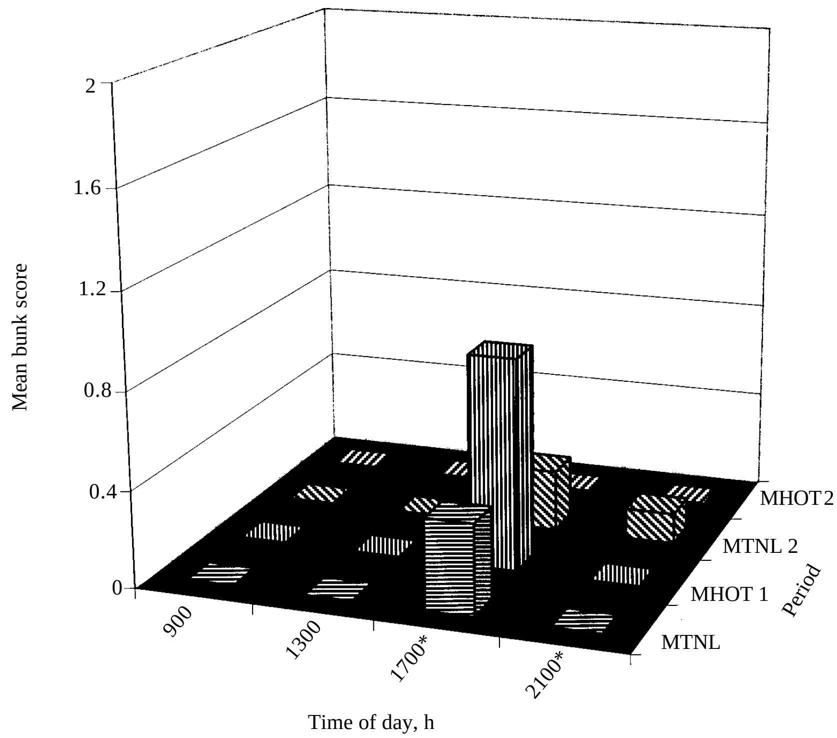

Figure 3. Effect of limit feeding on bunkscores during varying environmental conditions. MTNL 1 = Thermoneutral conditions (days 9 and 13); MHOT 1 = Hot environmental conditions (days 11 - 12); MTNL 2 = Thermoneutral conditions (days 14 - 15); and MHOT 2 = Hot environmental conditions (days 21 - 22). *Bunk scores differ (Chi-square P-value < .05).

Table 2. Main effect means of tympanic temperature for feeding regime (top table) and coat color (bottom table) of yearling feedlot steers under varying environmental conditions.

	Treatments[a]			
Period	ADLIB	BKMGT	LIMFD	SEMc
MHOT 1	101.8	101.9	101.8	< .1
MTNL 2	102.1[d]	101.7[e]	102.0[d]	< .1
MHOT 2	102.6[d]	102.2[e]	101.7[f]	.1
AHOT[g]	103.6[d]	102.8[e]	102.0[f]	.1

	Coat color		
Period	Black	White	SEM[c]
MHOT 1	102.0[d]	101.7[e]	< .1
MTNL 2[g]	101.9	101.9	< .1
MHOT 2	102.4[d]	102.0[e]	< .1
AHOT	103.0[d]	102.6[e]	.1

[a]MHOT 1 = Hot environmental conditions (temperature-humidity index; THI > 74) during managed feeding (days 0 – 23), MTNL 2 = thermoneutral conditions (THI < 74) during managed feeding, MHOT 2 = a second episode of hot environmental conditions during managed feeding, AHOT = hot environmental conditions during *ad libitum* feeding (days 23 – 82).
[b]ADLIB = ad libitum feeding at 0800 h, BKMGT = fed at 1600 h with bunks slick by 0800 the following day, LIMFD = fed 85% of predicted dry matter intake at 1600 h.
[c]Standard error of the mean
[def]Means within a row differ (P < .05)
[g]Main effect interaction with time (P < .05)

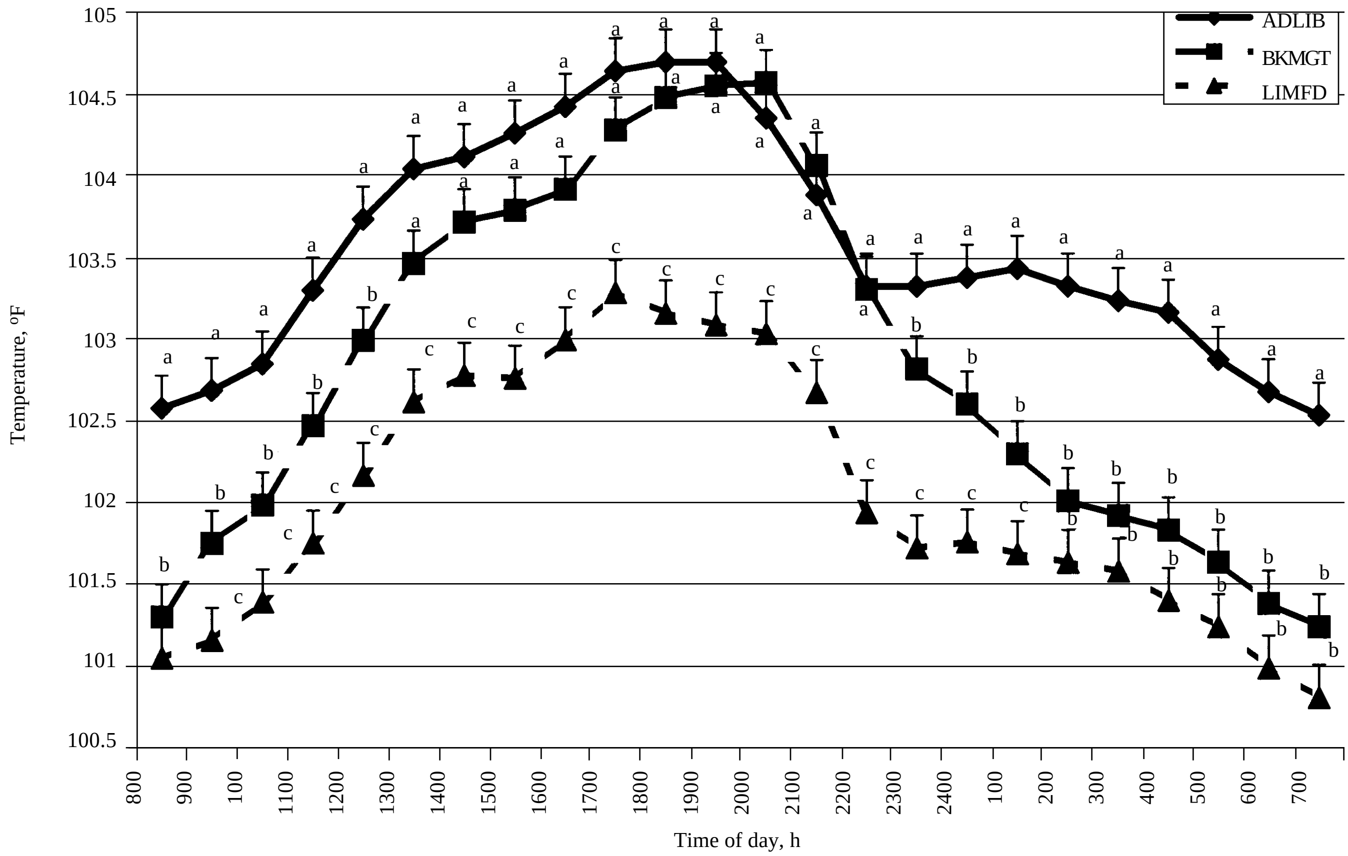

Figure 4. Effect of feeding regimen on tympanic temperature of yearling feedlot cattle during hot (temperature-humidity index > 74) environmental conditions during ad libitum feeding (days 36 - 38). [abc]**Values within a time differ (P < .05).**

animals. However, there is no evidence to suggest that TT of *Bos taurus* steers is affected solely by breed. Furthermore, the group was of similar genetic composition.

The lowered TT of LIMFD steers during the MHOT 2 period was likely due to decreased metabolic rate that often accompanies prolonged feed restriction. The lack of TRT differences in these animals earlier in the feeding period (MHOT 1; days 10 – 12 and MTNL 2; days 13 - 15) suggests decreased TT in response to limit-feeding is not instantaneous. Although, coat color affected TT during the MHOT 2 period with black-haired steers having higher (P < .05) TT than white-haired steers.

When all steers were placed on ad libitum feeding at 0800 hr, carryover effects of TRT were evident. A TRT by time interaction was noted for TT during the AHOT period (days 34 - 36; Figure 4). Limit-fed steers had lower (P < .05) TT than ADLIB steers at all times measured with BKMGT cattle being intermediate. Bunk management steers were lower than ADLIB steers from 2300 – 1200 hr. The reduced TT of LIMFD steers following ad libitum feeding is an important finding and suggest benefits of limit-feeding cattle during period of potential heat stress are not restricted to only the time in which the cattle are limit-fed. Reductions in the TT of BKMGT relative to ADLIB steers may partially be attributed to lower DMI during the days which TT were recorded (18.14, 17.45, 18.72 lb/day for ADLIB, BKMGT, and LIMFD, respectively).

Altering the feeding regimen of feedlot steers during the summer is a management strategy available to producers to mitigate adverse effects high summer temperatures have on performance. These changes may alter tympanic temperature and eating pattern without compromising overall performance. If limit-feeding is chosen as a means to reduce overall heat load of feedlot steers, it should be initiated for at least two weeks before potentially hot weather and, based on these results, may by stopped approximately two weeks prior to the last threat of heat stress. Bunk management strategies, such as the one employed in this study, appear to have more immediate effects on reducing body temperature.

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