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Restricted Feeding Strategies for Reducing Heat Load of Yearling Steers

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Restricting intake in feedlot cattle lowered body temperature during the summer.

Summary

*Eighty-four **Bos taurus** crossbred steers were used to investigate effects of level and duration of limit feeding feedlot cattle in a hot environment. Restricting feed intake to 70 to 80% of ad libitum for 21 days duration (RES21) or for 42 days duration (RES42) reduced tympanic temperature in both RES21 and RES42 when compared with ad libitum treatment groups under both thermoneutral and hot conditions. Temperature reduction approached 1.5 F^{0} depending on time of day. Limit feeding feedlot cattle during early summer is a successful tool for enhancing animal comfort by alleviating the combined effects of high temperatures and relative humidities.*

Introduction

Estimated economic losses to heat stress in Nebraska alone exceeded $20 million in 1999 due to reduced performance and cattle death. A major source of economic loss to heat stress is the reduction in feed intake, though the response is variable and dependent on the animal's thermal susceptibility, acclimation and diet. However, a managed or controlled reduction in feed intake to lessen heat stress may not cause an economic loss. In some situations feed restriction increases feed efficiency in ruminants, possibly by lowering maintenance energy expenditure and increasing diet digestibility. A further effect of feed restriction is a possible change in diurnal range of internal body temperature. Our study was undertaken to investigate effects of level and duration of restricted feeding of feedlot cattle in a hot environment on growth, feed efficiency and metabolic response. In addition, ad libitum feeding of a high-energy, high fiber diet, containing corn gluten feed (CGF), was compared to ad libitum feeding of a traditional dry rolled corn (DRC) based diet during the summer.

Procedure

As a part of a previously reported study (2000 Nebraska Beef Report, pp 41-43), 84 *Bos taurus* crossbred steers were used in a 63-day study, beginning June 24, 1998, to assess body temperature and behavior pattern of feedlot cattle. Steers were blocked by weight. Within a block, steers of similar color were randomly assigned to each pen to ensure a similar number of red, white and black coated cattle were equally distributed within each pen. Pens of steers were then randomly assigned to treatments. Treatments were: 1) CGF-based ration restricted to 70 to 80% of ad libitum for 21 days duration (RES21), 2) CGF-based ration restricted to 70 to 80% of ad libitum for 42 days duration (RES42), 3) CGF-based ration fed ad libitum (CGFAD), and 4) DRC-based ration fed ad libitum (DRCAD). Cattle on RES21 and RES42 treatment groups were stepped up over four to six days to ad libitum following the 21- and 42-day restriction. Daily dry matter intake of steers on CGFAD and DRCAD was projected using computer software (NRC, 1996), based upon breed type, age, body

Table 1. Composition (DM basis) of corn gluten feed (CGF) and dry rolled corn (DRC) based diets.

Item	CGF	DRC
Ingredient, %		
Corn silage	8	10
CGF	40	0
DRC	49	79
Soybean meal	0	4.5
Liquid supplement	0	4.5
Dry supplement	3	2
Chemical		
Crude protein, %	13.5	13.5
NDF, %	22.2	11.8
Dry matter, %	65.7	72.3
NEm Mcal/cwt	97.6	96.3
NEg, Mcal/cwt	67.0	66.0

Table 2. Dry matter intake, lb/day for each period and over the entire study.

	Treatment[a]			
	RES21	RES42	CGFAD	DRCAD
Period 1 (day 1-21)	18.6[b]	18.5[b]	24.5[d]	20.6[c]
Period 2 (day 22-42)	23.8[c]	18.7[b]	24.9[d]	26.1[e]
Period 3 (day 43-63)	26.0[c]	24.7[b]	26.7[c,d]	27.2[d]
Overall (day 1-63)	22.8[c]	20.7[b]	25.4[d]	24.7[d]

[a]RES21 & RES42 = restricted fed corn gluten feed based diet (CGF) for 21 and 42 days, respectively. CGFAD & DRCAD = ad libitum fed CGF and dry rolled corn based diet (DRC), respectively.
[b,c,d,e]Means within a row with different superscripts are different ($P < .05$).

Table 3. Mean tympanic temperature (TT) of feedlot cattle fed under hot climatic conditions[a]

	Treatment[a]			
	RES21	RES42	CGFAD	DRCAD
Day 1-21	102.7[c]	102.6[c]	103.2[d]	103.3[d]
Day 22-42	102.8[d]	102.2[c]	102.8[d]	103.0[e]
Day 43-63	102.0[d]	102.5[e]	102.1[d]	101.7[c]
Overall (day 1-63)	102.5[c]	102.5[c]	102.8[d]	102.9[d]

[a]Climatic conditions where mean daily THI was equal to or greater than 74.
[b]RES21 and RES42 = restricted fed corn gluten feed based diet (CGF) for 21 and 42 days, respectively. CGFAD and DRCAD = ad libitum fed CGF and dry rolled corn based diet (DRC), respectively.
[c,d,e]Means within a row with different superscripts are different ($P < .05$).

condition and frame size. The DMI of RES21 and RES42 were adjusted accordingly from the projected amount. Diets (Table 1) were formulated to contain a minimum of 13.5% CP, .63% Ca, .35% P, and .65% K, and contained 25g/ton Rumensin and 10 g/ton Tylan (DM basis). Steers were implanted with Revalor-S® at the beginning of the trial. All steers were fed in the morning at approximately 0800.

Steers were weighed at approximately 0800 on two consecutive days (d -1 and 0), prior to the start of the trial, to obtain an average starting weight. Steers were then weighed on days 21, 42, and 63.

Temperature (T_a °F), relative humidity (RH, %), and other climatic data were collected hourly throughout the study via a weather station located at the feedlot facilities. The primary indicator of heat load was temperature-humidity index (THI); $THI = T_a - (.55 - .55(RH/100)) \times (T_a - 58)$.

During each of the three 21-day periods, thermistors were inserted into an ear canal of a total of 12 steers (two/ad libitum groups and four/limit-fed groups) within each treatment for approximately a seven-day period to obtain tympanic temperature (TT) on an hourly basis. Steers were selected based on coat color and weight in an attempt to compare similar steers among treatments. Thermistor leads were placed into the ear canal, close to the tympanic membrane, to an approximate depth of five inches. Data loggers (Onset Data Loggers, Pocassatt, MA.) were then connected to the thermistor, wrapped with padded gauze, placed on the inside of the ear and secured to the ear.

Within each period, behavior data (panting and bunching) were obtained during thermoneutral (TNL) days (THI less than 74) and hot (HOT) days (THI equal to or greater than 74) at 1600. Panting score was obtained by visual assessment of flank movements and overall breathing in individual steers. A score of 1 indicated little or no panting and 2 indicated moderate to excessive panting with mouth opened and/or salivation occurring. At the same time, a bunching score was assigned. This measure indicates the proximity of each animal to its nearest neighbor (within a pen), where 1 indicates animals are bunched (any part of one animal within 3 feet of the midline of any other animal, with midline determined from shoulders to tailhead) and 2 indicates animals are separated from others.

Results

For the study's duration, THI averaged 71.5 and ranged from a daily average of 64.2 to 79.4. Mean daily ambient temperature for the entire study was 73.4 °F with an average daily low and high of 65.0 and 83.4 °F, respectively, while relative humidity ranged from 60% to 98% with a mean of 83.6%.

By design, differences in DMI were found among treatments ($P < .05$) during restricted feeding periods (Table 2). These differences tended to be carried over into subsequent periods, in which cattle previously restricted in DMI also had significantly lower DMI during the period following restriction.

Differences in tympanic temperature (TT) were found among treatments within periods ($P < .05$; Table 3). Restricting DMI reduced TT .6 to .8 °F when compared to ad libitum fed cattle. On the average, cattle fed ad libitum diets (CGFAD vs DRCAD) had equal TT, even though the CGFAD treatment group consumed a slightly greater quantity of feed. The greatest environmental challenge was experienced in period 2 (day 22 to 42), in which both maximum ambient temperature and maximum THI were obtained. During this period the cattle remaining on the restricted DMI diet (RES42) had the lowest overall TT. The greatest differences in TT, between this group and the other treatment groups, began to occur between 1600 and 1700 hr. The TT in the RES42 group remained 1.0 to 2.0°F below the TT of cattle in the other groups, throughout the nighttime hours (Figure 1). On the average, TT of the other groups began to decline approximately four hours later than TT of the RES42 cattle group.

Within respective periods, no differences ($P > .05$) were found among treatments for panting or bunching score in either thermoneutral (TNL) or hot (HOT) climatic conditions. However, within treatments, different proportions of cattle were bunched and panting (Table 4). This is particularly evident in periods 2 and 3, in which cattle assigned to the CGFAD treatment had the greatest percentage of cattle bunched and a greater percentage of cattle panting. In general,

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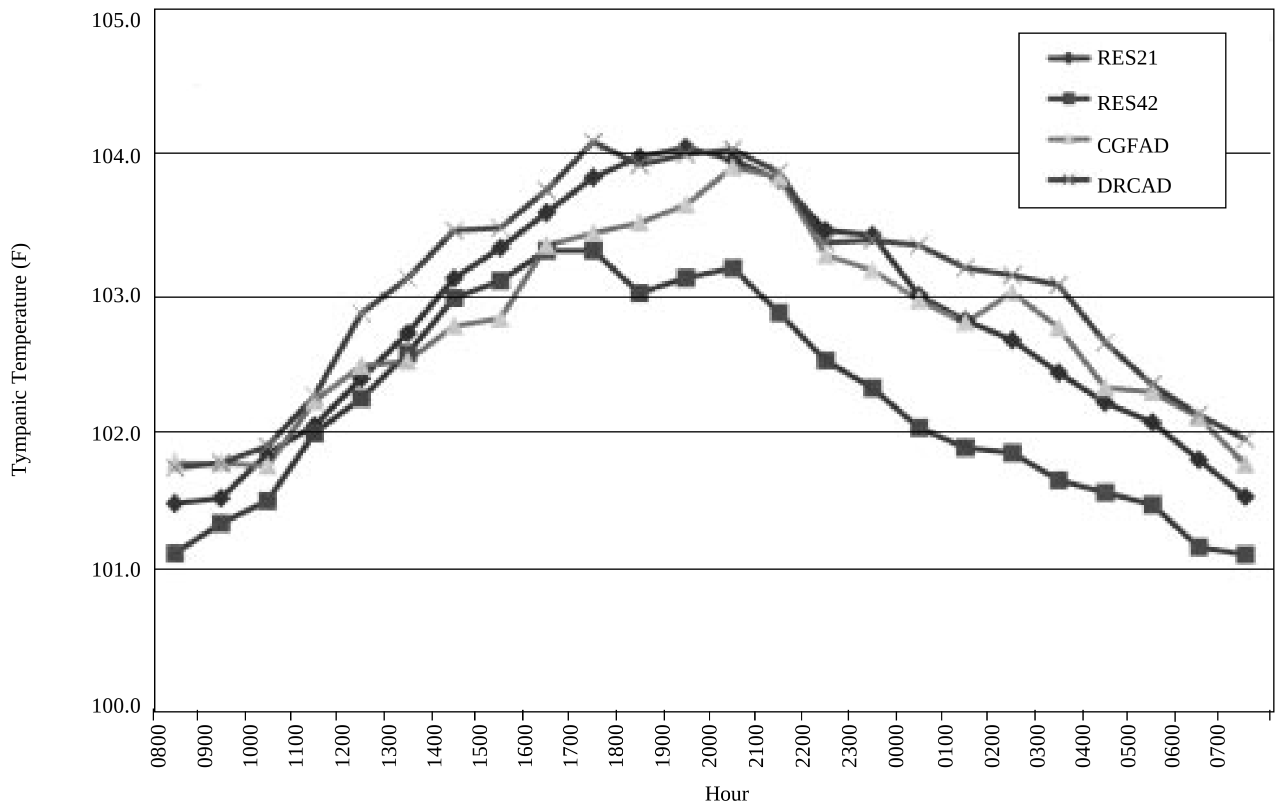

Figure 1. Hourly tympanic temperature (TT) of cattle fed various diets from day 21 to day 42.

Table 4. Chi square analysis of percentage of cattle panting and bunching by treatment and period.

	Panting score[a] (period 1)			Panting score[a] (period 2)			Panting score[a] (period 3)		
Item	1	2	P value	1	2	P value	1	2	P value
RES21									
Bunching score[b]									
1	84	79.17		74.45	85.27		80.95	92.38	
2	16	20.83	.38	25.55	14.73	.028	19.05	7.62	.03
RES42									
Bunching score[b]									
1	79.05	85.71		77.93	90.08		80.88	90	
2	20.95	14.29	.22	22.07	9.92	.008	19.12	10	.092
CGFAD									
Bunching score[b]									
1	83.33	73.21		84.72	94.12		86.84	98.28	
2	16.67	26.79	.24	15.28	5.88	.07	13.16	1.72	.024
DRCAD									
Bunching score[b]									
1	83.33	86.84		85.51	89.47		83.87	95.12	
2	16.67	13.16	.7	14.49	10.53	.5	16.13	4.88	.11

[a]Panting score 1 = % of cattle showing little or no panting, 2 = % of cattle showing moderate to excessive panting.
[b]Bunching score 1 = % of cattle bunched together, 2 = % of cattle not bunched.

cattle that are panting tend to display a greater level of bunching. Bunching is often observed with cattle under heat stress and possibly contributes to added heat load by diminishing air flow.

Coat color (black or white) was found to have significant ($P < .01$; Table 5) effect on panting score. When averaged across diet treatments, black cattle had the greatest percentage of cattle showing moderate to excessive panting, while white cattle displayed the least panting under TNL climatic conditions. A similar pattern was seen under HOT climatic conditions. The percentage of cattle showing moderate to excessive panting increases approximately 30% from TNL to HOT conditions. Only when cattle were exposed to HOT climatic conditions did trends in bunching become apparent. Under HOT conditions, dark

Table 5. Chi square analysis of percentage of cattle panting and bunching by climatic conditions and coat color.

	Hide color		
Item	Black	White	*P* value
Thermoneutral conditions (THI < 74)			
Panting score[a]			
1	54.39	77.19	
2	45.61	22.81	< .01
Bunching score[b]			
1	78.72	78.36	
2	21.28	21.64	.95
Hot conditions (THI 74)			
Panting score			
1	27.64	48.29	
2	72.36	51.71	< .01
Bunching score			
1	90.7	85.04	
2	9.3	14.96	.073

[a]Panting score 1 = % of cattle showing little or no panting, 2 = % of cattle showing moderate to excessive panting.
[b]Bunching score 1 = % of cattle bunched together, 2 = % of cattle not bunched.

cattle bunched more ($P < .08$) than white cattle. Since cattle of different coat colors were in the same pens, it would appear that the white cattle tend to stay away from the dark cattle. Whether they are not bunching because they are cooler, having fewer problem with flies than black cattle, or sense heat coming from the black animals, is not known. Although not shown, observed effects of coat color on bunching tended to diminish over time, particularly from period 2 ($P < .03$) to period 3 ($P < .14$). Thus, the percentage of white animals bunching appears to increase over time, as body condition and days of feed increase. These data suggest that as white cattle get fatter, they tend to behave more like the black cattle under hot conditions.

Under hot environmental conditions, heat loads can be reduced by restricted feeding which is beneficial in protecting cattle from the effects of hot, humid conditions. However, the preferred length of time to limit-feed, prior to a heat episode, is still in question. Immediate benefits to restricting DMI occur by reducing metabolic heat load, however, additional benefits likely occur, longer term, in which metabolic rate and associated heat production are reduced.

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