Proc. Aust. Soc. Anim. Prod. 1996 Vol. 21

EFFECT OF FEEDING REGIME ON FEED INTAKE OF CATTLE EXPOSED TO HEAT

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SUMMARY

The effect of high temperature and feeding regime on dry matter intake (DMI), metabolizable energy intake (MEI), respiration rate (RR), pulse rate (PR) and rectal temperature (RT) of 6 Hereford steers was examined. Three feeding times 0800 h (am; 14% roughage fed), 1600 h (pm; 14% roughage fed) or a split feeding (sp; 30% roughage diet fed at 0900 h and 6% roughage fed at 1600 h) were imposed on the cattle housed in either a thermoneutral (TNL) or a hot environment (HOT). Steers fed under HOT had a greater mean and range in RT and respiratory rate (RR) than steers fed under TNL. In general, PR was more indicative of DMI than of heat load. Afternoon (pm) feeding was not found to be an effective method of maintaining DMI under HOT. As a percentage of body weight, steers fed pm under HOT had significantly lower MEI than other treatments, while steers fed am or sp under HOT were able to maintain DMI at a level equal to or greater than steers fed under TNL. In the HOT treatment, sp fed steers had lower minimum RT than am and pm fed steers and tended to have lower 1600 and 2000 h RT than am fed steers. Managing heat load during periods of high ambient temperature by altering feeding regime may be effective in maintaining intake for feedlot cattle.

Keywords: beef cattle, thermal load, feed intake, rectal temperature, respiration rate

INTRODUCTION

Thermal load associated with high ambient temperatures which cause an increase in energy requirement, a decrease in intake and a reduction in growth rate in beef cattle, can represent considerable economic losses to feedlot operators. This is of particular relevance to Australian feedlots situated in sub-tropical and tropical environments where ambient temperature and humidity may exceed critical levels during much of the day in the summer months. Additionally, in temperate regions, unexpected periods of heat load may impose serious problems where cattle are not physiologically adapted to hot conditions (Young and Hall 1994).

High ambient temperature resulting in an increase in internal body temperature of cattle will reduce feed intake and change eating patterns (De Dios and Hahn 1993). In addition Reinhardt and Brandt (1994) reported that ruminal fermentation of high quality grain diets peaks within 12 hours after consumption. Therefore daily morning feeding results in maximum heat from fermentation during the hottest part of the day. This suggests that cattle consuming the highest energy components of their diets during late evening or at night during summer may be better able to cope with heat load and utilise metabolizable energy more efficiently than those fed in the morning immediately prior to maximum daily heat load.

This study was undertaken to evaluate physiological responses and feed intake patterns using different feeding regimes (morning feeding (am), evening feeding (pm) or split feeding (am/pm)) in cattle subjected to thermoneutral (TNL) or hot (HOT) environments.

MATERIALS AND METHODS

Six yearling Hereford steers with an average weight of 279 kg were randomly assigned to individual stalls (3m x lm) in 1 of 2 temperature controlled rooms. Each animal was restrained in its stall by a head halter. The steers had previously been trained and were quiet. The feeding treatments were a 14% roughage diet (7% oat hay and 7% luceme hay) provided at 0800 h each day (am), the same diet as in am but fed at 1600 h (pm) and a split feeding regime (sp) in which approximately one-third of the dietary intake was provided from a 30% roughage diet fed at 0800 h with the remaining dietary intake provided from a 6% roughage diet fed at 1600 h. Total diet consumed in the sp group approximated the composition of the 14% roughage of the other 2 treatments. Water was available *ad-libitum*. The trial was replicated 3 times with steers being assigned to a new feeding regime and environmental conditions using an incomplete latin square design. The 6% roughage diet was formulated to contain 12.2 MJ ME/kg, the 14% roughage diet was formulated to contain 11.8 MJ ME/kg and the 30% roughage diet was formulated to contain 11.2 MJ ME/kg. All diets contained 14% crude protein. The grain portion of each diet consisted of 50% rolled sorghum and

50% rolled barley. A protein concentrate (Farmstok; Toowoomba) fed at 5% of the diet was used to balance protein and provide Rumensin at 27.5 g/tonne.

Steers were accustomed to each feeding treatment over a 7 day period, during which time ambient temperature was kept below 30° C. Feed intakes and refusals were recorded daily throughout the trial. During the test period (3 days each), the HOT room had the capacity to be heated and was maintained at temperatures between 24° C and 39° C whilst the TNL room was maintained at temperatures between 22° C and 3 1 ° C. High temperatures were imposed in the HOT room starting at 1000 hours and ending at 1800 hours. Even heat distribution was ensured by the use of a variable speed fan. A gradual cool down to TNL conditions was allowed at night to depict normal cyclic daily temperatures. The TNL room was also allowed to follow a cyclic temperature regime.

Feed intake (DMI) and MEI were determined daily for each steer. During the 3 day test periods respiration rate (visual observation for 60 seconds), pulse rate (PU-701 infrared pulse monitor; Sun Medical, Brisbane) on the left ear, were taken at 0900, 1600 and 2000 hours. Ambient temperature and humidity were recorded continuously (Mini-logger temperature/humidity logger; Mini-Mitter, USA). Rectal temperature of each steer was recorded every 592 seconds (Smart Reader 8; ARC Systems, Brisbane), for the duration of the trial.

RESULTS

Climatic variables

Mean temperature in the TNL room over the test period was 25.8° C and ranged from 21.9 to 3 1.4°C; relative humidity (RH) ranged from 58% to 93% (mean 74%). The temperature humidity index (THI = (dry bulb temperature C} + (0.36 dew point temperature' C} + 41.2) (Armstrong 1993) ranged from 70 to 85 and had a mean of 75. The mean temperature of the HOT room was 30.2° C and ranged from a maximum of 39.4 to a minimum of 24. 1° C, whilst the mean RH was 69% and ranged from 41 to 95%. The THI in the HOT room ranged from 73 to 92 and had a mean of 82. The mean THI between 1200 and 1800 hours was 88 in the HOT room and 74 in the TNL room. This represents a 16% difference in THI between the rooms during the hottest part of the day. During this period mean temperature in the HOT room was 35.7°, C which was 10.6° C higher than in the TNL room (25.1 ° C).

Physiological measurements

Mean respiration rates (RR) measured at 1600 and 2000 h differed (P < . 10) between steers fed under TNL vs HOT conditions (Table 1). Within feeding regime, RR was not affected. In contrast, pulse rate (PR) was significantly influenced by feeding regime at 1600 hours, in which pm fed steers had the lowest PR while sp fed steers had the highest PR. At 0900 h, PR of the TNL treatment were higher than PR in the HOT treatment. Steers exposed to HOT environmental conditions had greater RT at 1600 and 2000 hours, however environmental conditions by feeding interactions existed at both times. In, general, under TNL conditions RT was the least with am feeding and greatest with sp feeding. An opposite trend was evident under HOT conditions. Even though the interaction was not apparent, these same trends were evident for 0900 hours PR.

These same trends were also observed in the daily RT values shown in Table 2. The RT values were greatest in the HOT am treatment, but least in the TNL am treatment, on most days and over the entire trial. Over the entire trial, environmental conditions by feeding regime interactions were found for mean MAX and MIN RT. In general MAX and MIN RT values for the TNL sp treatments were greater than respective RT values of other TNL treatment; while the RT values of the HOT sp treatment tended to be lower than respective RT values of the other HOT treatments. As expected, the range in RT values were greater in the HOT treatment than in the TNL treatment. Ranges in RT tended to increase from day 1 to day 3 in the HOT treatment group only.

Feed intake

Under both environmental conditions sp fed steers had the greatest DMI and MEI (Table 3). Under TNL conditions, pm fed steers maintained equal intakes to sp fed steers, which tended to be greater than am fed steers; however, under HOT conditions pm fed steers had intakes of, as a percentage of BW, 12.3% and 13.6% respectively lower than am and sp fed steers. Steers that were fed sp under HOT conditions appeared to be better able to distribute MEI throughout the 24 hour period, thus minimising heat load by achieving lower mean and MIN RT than other steers fed under HOT conditions.

Table 1. Mean respiration rate (RR), pulse rate (PR) and rectal temperature (RT), measured at 0900, 1600 and 2000 hours, for steers exposed to thermoneutral (TNL) or hot (HOT) environmental conditions (ENV)[A]

ENV:	TNL			HOT			
Feeding regime	am	pm	sp	am	pm	sp	SEM
RR (breaths/min)							
0900 hours	68.4	68.8	76.2	88.0	80.1	81.6	8.4
1600 hours[B]	72.8	81.0	88.7	136.2	136.2	130.7	6.3
2000 hours[B]	87.0	96.8	101.3	113.7	115.7	114.8	7.0
PR (beats/min)							
0900 hours [B]	95.0	97.3	98.6	92.2	90.9	88.7	2.3
1600 hours	94.6	90.3	97.4	96.4	93.3	98.4	3.7
2000 hours	97.5	92.3	97.6	97.7	101.4	107.3	6.8
RT ° C							
0900 hours	38.8	38.8	39.0	39.0	39.0	38.8	0.08
1600 hours[BC]	38.8	39.0	39.3	40.6	40.3	40.1	0.20
2000 hours[BC]	39.2	39.3	39.7	40.4	40.1	40.1	0.10

[A] The am and pm fed diets contained 14% roughage while the sp diet contained 30% roughage during the morning feeding and 6% roughage during the afternoon feeding. [B] TNL vs HOT, P<0.1. [C] ENV by feeding regimes interaction, P<0.1.

Table 2. Mean, maximum (max), minimum (min) ± range in rectal temperature for steers exposed to thermoneutral (TNL) or hot (HOT) environmental conditions (ENV)[A]

	DAY					
	1[BC]	2[BC]	3[BC]	Mean[BC]	Max[BC]	Min[BC]
TNL						
am	39.95 ±1.16	39.02 ± 1.21	39.10 ± 1.15	39.02 ± 1.34	39.69	38.35
pm	39.08 ±1.17	39.16 ± 1.30	39.19 ± 1.11	39.14 ± 1.59	39.95	38.40
sp	39.40 ±1.20	39.40 ± 1.39	39.50 ± 0.96	39.43 ± 1.41	40.10	38.77
HOT						
am	39.72 ± 1.53	39.92 ± 1.64	40.00 ± 1.84	39.87 ± 1.93	40.86	38.93
pm	39.55 ± 1.53	39.73 ± 1.68	39.77 ± 1.73	39.67 ± 1.82	40.56	38.74
sp	39.48 ± 1.63	39.62 ± 1.89	39.67 ± 2.31	39.58 ±2.14	40.66	38.51
SEM	0.13	0.14	0.14	0.13	0.20	0.07

[A] The am and pm fed diets contained 14% roughage while the sp diet contained 30% roughage during the morning feeding and 6% roughage during the afternoon feeding. [B] TNL vs HOT, P<0.10, [C] ENV by feeding regime interaction, P<0.10.

DISCUSSION

Under HOT conditions mean RT of pm fed steers tended to remain elevated above sp fed steers, while maximum RT tended to be less for pm fed steers (day 2, day 3 and over entire trial). Under HOT conditions, am and pm fed steers had consistently greater daily minimum RT than sp fed steers. The inability to dissipate body heat and return to a state of normalcy most likely impacts post-heat feeding behaviour. Feeding pm tended to reduce maximum RT compared to am and sp feeding, but it did not allow for the lower RT that was observed in the sp fed group.

Although PR appeared not to be elevated during heat load, the lower PR for the HOT group at 0900 hours, when the steers were not exposed to heat load, corresponds to the lower DMI (%BW) and MEI (%BW) of the HOT group. Similar relationships between PR and feed intake have been reported by Brosh *et al.* (1994).

Data suggests that under HOT conditions, minimum RT may have a greater influence on subsequent intake rather than the previous maximum RT. Cattle consuming large quantities of feed in the afternoon (pm) may not experience the degree of RT reduction normally associated with night-time cooling. By sp feeding under HOT conditions, DMI were as great or greater than under any TNL diet regime. Intakes as a percentage of BW were able to be maintained and not reduced as is usually the case under heat load. Intakes appear to be maintained as a result of lower mean and minimum RT.

Managing heat load by altering feeding regimen may be effective in maintaining intakes of feedlot cattle exposed to hot environmental conditions. Although pm feeding would appear to aid in minimizing heat load, intakes were reduced under HOT conditions when compared to am and sp feeding regimes. Under both HOT and TNL conditions sp fed cattle tended to have greater intakes than am fed cattle. Lower mean and minimum RT of the sp cattle fed under HOT may aid in keeping cattle on feed and minimizing intake reductions often associated with high ambient temperatures.

Table 3. Mean daily dry matter intake (DMI) and metabolizable energy (MEI) consumed for cattle fed feedlot diets and exposed to thermoneutral (TNL) or hot (HOT) environmental conditions (ENV)[A]

ENV	TNL			HOT			
Feeding time	am	pm	sp	am	pm	sp	SEM
DMI (kg/day)[B]	7.32	7.48	7.48	7.17	6.49	7.56	0.23
DMI (% BW)[CD]	2.62	2.72	2.72	2.60	2.28	2.64	0.09
MEI (MJ)[B]	86.69	88.55	88.68	84.61	76.62	89.94	2.72
MEI (% BW)[CD]	31.07	32.19	32.26	30.67	26.90	31.43	0.25

[A] The am and pm fed diets contained 14% roughage while the sp diet contained 30% roughage during the morning feeding and 6% roughage during the afternoon feeding. [B] Feeding regimes differ, ($P < .10$).
[C] Expressed as a % of body weight;TNL vs HOT ($P < .10$). [D]ENV by feeding regime interaction ($P < .10$).

ACKNOWLEDGEMENTS

The authors would like to thank Mr George Brunhold (Utronics) for design and maintenance of electrical components, Mr Andy Goodwin, Mr Steve Fennel and Mr Ian Williams.

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