EAAP 2009
60th Annual Meeting of the European Federation of Animal Science
Fira de Barcelona, Barcelona, Spain August 24-27, 2009

Session 9

Heat stress response of some local and European breeds of feedlot beef cattle grown under the Mediterranean climate conditions

Y. Bozkurt and S. Ozkaya

Suleyman Demirel University, Faculty of Agriculture, Department of Animal Science, Isparta, Turkey, 32260. ybozkurt@ziraat.sdu.edu.tr

Abstract

In this study, data from Holstein (10), Brown Swiss (26), Simmental (8) cattle as European breeds (EB) and Boz (12) and EAR (East Anatolian Red, 47) as local breeds (LB) grown under feedlot conditions were used to evaluate and compare performance differences in the Mediterranean type of climate in response to heat stress. Initial mean weights of cattle were 198.5, 195.8, 213.1, 202.5 and 223.2 kg for Holstein, Brown Swiss, Simmental, Boz and Gak respectively. There were statistically significant ($P< 0.05$) differences in daily live weight gains (DLWG) of both type of cattle. Although there was no significant ($P> 0.05$) interaction between temperature and breed types, liveweights of both type of cattle were affected by the heat and the weight gains were decreased as the temperature and humidity increased. There were no statistically significant ($P< 0.05$) differences in performance between EB cattle and between LB cattle themselves. However, Simmentals tended to perform better than the rest. The results showed that under the Mediterranean conditions EB cattle were better suited to the feedlot beef systems than LB cattle.

Introduction

Livestock performance is affected by heat stress because an animal having difficulty in losing heat will decrease its heat production by lowering feed intake. Heat stress affects the maintenance energy because the body may be at higher temperature resulting in greater metabolic action and also energy is used to increase heat dissipation (Morrison 1983). Metabolic heat includes that necessary for maintenance plus increments for exercise, growth, lactation, gestation and feeding. High rates of these activities will result in more heat gain from metabolism than will low rates (Fuquay, 1981).

Heat stress is caused by those factors that decrease heat transfer from an animal to its environment, which would include high air temperature, high air humidity, low air movement and thermal radiation load. Air temperature is usually the primary cause of heat stress, although other factors may intensify the stress (Morrison 1983). During hot periods, cattle show signs of disrupted behavior, impaired physiological functions, and an increased incidence of morbidity. Performance of feedlot cattle is typically better in summer than in the winter. However, summer economic loses attributed to environmental causes can equal on exceed those incurred in the winter, because more deaths from heat stress than from cold stress can occur (Hahn and Mader 1997). Summertime temperatures, humidity and solar heat often cause discomfort and even death of feedlot cattle (Curtis 1981; Marrison and Porkop 1983; Young 1993; Lefcour and Adams 1996). Excessive heat loads reduce feed intake and expenditure of energy in maintaining homeothermy (NRC 1981).

Mitlöhner et al. (2001) reported that cattle without shade had a physiological and behavioral stress response to heat that negatively affected productivity, and also, providing shade for beef cattle was a suitable solution to decrease heat stress and to lower the negative effects of heat on performance.

Pereira et al. (2008) reported that Frisian animals had more difficulty in tolerating high temperatures, the Limousine and Alentejana ones had an intermediate difficulty, and the Mertolenga animals were by far the most heat tolerant.

A study showed that a hot environment adversely affected eating behavior of the bulls while the higher rumination activity represented an attempt to cope with peak of fermentative activity in the rumen which follows the main meal of the animal right after the provision of the fresh TMR. Behavioral observation of beef cattle reared in indoors systems are a useful tool to develop and test cooling devices and management strategies to improve beef cattle welfare and performance during the hot season (Brscic et al. 2007).

The objectives of this study were to determine the response heat stress of some local and European breeds of feedlot beef cattle grown under the Mediterranean climate conditions.

Materials and Methods

The experiments were conducted at the Suleyman Demirel University experimental feedlot in Isparta over a period summers and autumn. Experiment took place from July 12 to October 10, 2000.

One hundred and three bulls, 10 Holstein, 8 Simmental, 26 Brown Swiss, 12 Boz, 47 East Anatolian Red , were used. The initial average body weights were 198.5±8.4 kg; 213.1±11.9 kg; 195.8±8.6 kg; 202.5±10.5 kg and 223.2±4.6 kg, respectively. Animals were weighed using a mobile weighing bridge monthly.

Weather temperatures and humidity were obtained by meteorological office in Isparta. THI (Temperature-humidity index) values were determined using the fallowing equation (Bouraoui et al. 2002):

$$THI = 1.8xT \quad (1 \quad RH)x(T \quad 14.3) \mid 32$$

Where T is the dry bulb temperature of outdoor air hourly measured (^{o}C), RH is the relative humidity of outdoor air hourly measured (as a fraction of the unit). THI values also serve as the basis for livestock weather safety index (LCI 1970): normal, ≤ 74; alert, 75-78; danger, 79-83; emergency, ≥ 84.

The GLM procedure in MINITAB (Version 13, State Collage, PA, USA 2001) was used for analyses. The model included the effects of breeds, temperature and breeds x temperature.

Results

Summers in Isparta are generally characterized by hot daytime temperatures and relatively cool nighttime temperatures. Climatic measures on a monthly during experiment are shown in Table 1.

Table 1. Climatic measures during experiment in 2000.

Climatic parameter	July	August	September	October
Air temperature, ^{o}C				
Min[a]	17.5	16.8	11.9	9.7
Max[b]	25.5	26.1	19.2	15.4
Avg	23.2	21.4	16.2	12.5
Relative humidity, %				
Min[a]	44.9	41.4	66.1	64.8
Max[b]	100.0	82.7	89.7	88.93
Avg	61.5	60.2	76.4	75.4
THI				
Min[a]	63.5	61.3	54.2	50.0
Max[b]	74.0	72.9	65.6	59.4
Avg	70.2	67.6	60.7	54.9

[a] Average minimum daily temperature
[b] Average maximum daily temperature

The monthly average values of outdoor air dry bulb temperature decreased and the relative humidity increased towards October (Table 1).

Performances of animals are shown in Table 2. BW obtained monthly.

Table 2. Performance of animals.

	N	July (Initial BW)	August	September	October (Finally BW)	ADG, kg/d
Holstein	10	198.5±8.4	220.5±9.1	247.9±9.2	277.2±8.9	0.874
Simmental	8	213.1±11.9	237.0±11.8	264.5±11.9	294.8±11.9	0.908
Brown Swiss	26	195.8±8.6	218.9±9.5	244.7±10.1	272.2±10.3	0.848
Boz	12	202.5±10.5	221.8±11.5	238.8±12.3	256.3±12.5	0.598
EAR	47	223.2±4.6	239.6±4.61	258.2±4.9	272.1±4.9	0.543

The final BW on d 90 was 78.7, 81.4, 76.4, 53.8 and 48.9 kg/bull (277.2, 294.8, 272.2, 256.3 and 272.1 kg, respectively). There were statistically significant ($P< 0.05$) differences in daily live weight gains (DLWG) of both type of cattle. Although there was no significant ($P> 0.05$) interaction between temperature and breed types, liveweights of both type of cattle were affected by the heat and the weight gains were decreased as the temperature and humidity increased. There were no statistically significant ($P< 0.05$) differences in performance between EB cattle and between LB cattle themselves. However, Simmentals tended to perform better than the rest. The results showed that under the Mediterranean conditions EB cattle were better suited to the feedlot beef systems than LB cattle.

Discussion

Heat stress is known for its potential to affect performance by cattle. Morrison and Lofgreen (1979) studiet beef cattle responses by using three different climatic regimens (20.3, 24.1 and 29.3 ^{o}C). The difference between the higher and lower treatment groups (20.3 and 29.3 ^{o}C) showed heat stress induced decreases in ADG of 15%. Mitlöhner et al. (2001) showed a decrease in ADG of 11%. In present study also showed decrease in ADG. Hahn et al. (1974) found differences in BW of 20 kg between stressed and unstressed animals after a heat stress period.

Conclusions

The EB cattle were better performance than LB cattle under Mediterranean conditions.

References

Bouraoui, R., Lahmar, M., Majdoub, A., Djemali, M. and Belyea, R. 2002. The relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. *Anim. Res.*, 51: 479-491.

Brscic, M., Gottardo, F., Mazzenga, A. and Cozzi, G. 2007. Behavioural response to different climatic conditions of beef cattle in intensive rearing systems. Agriculture - Scientific and Professioanl Review.

Curtis, S. E. 1981. Enviromental management in animal agriculture. Animal Environmental Services, Mahomet, IL.

Fuquay, J. W. 1981. Heat stress as it affects animal production. *J. Anim. Sci.* 52: 164-174.

Hahn, G. L. and Mader, T. L. 1997. Heat waves in relation to thermoregulation, feeding behavior and mortality of feedlot cattle. *In: Proc. 5th Int. Symp. Trans. Am. Soc. Agric. Eng.* Bloomington, MN.

Hahn, L., Meador, N. F., Thompson, G. B. and Shanklin, M. D. 1974. Compensatory growth of beef cattle in hot weather and its role in management decisions. *Trans. ASAE (Am. Soc. Agric. Eng.)* 288-295.

LCI 1970. Patterns of transit losses.Conservation, Inc. Omaha, NE.

Lefcourt, A. M. and Adams, W. R. 1996. Radiotelemetry measurements of body temperatures of feedlot steers during summer. *J. Anim. Sci.* 74: 2638-2640.

MINITAB Institute. 2001. MINITAB User's Guide. Release 13 for Windows. MINITAB Inc. State Collage, PA. USA.

Mitlöhner, F. M., Morrow, J. L., Dailey, J. W., Wilson, S. C., Galyean, M. L., Miller, M. F. and mcGlone, J. J. 2001. Shade and water misting effects on behavior, physiology, performance, and carcass traits of heat-stressed feedlot cattle. *J. Anim. Sci.* 79: 2327-2335.

Morrison, S. R. and Lofgreen, G. P. 1979. Beef cattle response to air temperature. *Trans. ASAE (Am. Soc. Agric. Eng.)* 22: 861-862.

Morrison, S. R. and Prokop, M. 1983. Beef cattle response to air temperature: Effect of body weight and ration composition. *Trans. Am. Soc. Agric. Eng.* 26: 893-894.

Morrison, S. R. 1983. Ruminat heat stress: Effect on production and means of alleviation. *J. Anim. Sci.* 57(6): 1594-1600.

NRC. 1981. Effect of environment on nutrient requirements of domestic animals. Washington, DC.: National Academy Press.

Pereira, A. M. F., Baccari Jr, F., Titto, E. A. L., Afonso Almeida, J. A. 2008. Effect of thermal stress on physiological parameters, feed intake and plasma thyroid hormones concentration in Alentejana, Mertolenga, Frisian and limousine cattle breeds. *Int. J. Biometeorol* 52: 199-208.

Young, B. A. 1993. Implications of excessive heat load to the welfare of cattle in feedlots. *In: Recent Advances in Animal Nutrition in Avustralia. Univ.of New England.* Armidale, N.S.W. 45-50.