Physiological Changes in Steers After Acute Exposure to Either Cool or Hot Environmental Temperatures

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Story in Brief

Twenty-four steers (342±8 lb) were exposed to either 40±1, 65±1 or 90±1°F for 4 days (8 steers/group) after a 3-day acclimation period to restraining crates in environmental chambers at 65±1°F. In the steers exposed to 90°F, rectal temperatures, respiratory rates and water intake increased from pre-exposure values ($P<.01$). Hematocrit decreased in all groups throughout the trial ($P<.01$) but the decrease was most dramatic in the steers exposed to the high environmental temperature.

Introduction

Physiological changes in beef steers after acute changes in environmental temperatures are not clearly defined. The purpose of this investigation was to monitor changes in rectal temperature, respiratory rate, water intake and hematocrit during 4 days of exposure to either 40, 65 or 90°F. The environmental temperatures used were selected to be similar to acute variations in temperature which occur in Oklahoma.

Materials and Methods

Twenty-four Angus x Hereford steers (342±8 lb) were randomly assigned to one of three environmental temperatures of 40±1, 65±1 or 90±1°F with the relative humidity at 61±1 percent. Two environmental chambers with two steers per chamber were used in six replicates with two different environmental temperatures represented in each replicate. Two weeks prior to each replicate, four steers assigned to the replicate were penned indoors at a temperature of 65±5°F. Steers were transported to the environmental chambers and acclimated to the restraining crates and chambers at a temperature of 65±1°F with 12 hr of light daily commencing at 0600 hr. Steers were fed 3 lb of ground alfalfa hay, 3 lb cottonseed hulls and 1 lb of a 12 percent protein grain supplement per day with water *ad libitum*. After a 3-day acclimation period the steers were exposed to their preassigned temperatures (40, 65 or 90°F) with the chamber temperature changed at a rate of 5°F per hour. Steers were exposed to the environmental temperature for 3 days after the day of the temperature change. One day prior to the temperature change (Day -1), immediately prior to the temperature change (Day 0) and for the next 3 days, rectal temperature, respiratory rate, hematocrit and water intake were recorded (hematocrit was not taken the day prior to the temperature change).

Results and Discussion

Rectal temperatures of the steers increased as the environmental temperature and length of exposure to the chambers increased (Table 1; $P<.01$). In the steers exposed to

Table 1. Rectal temperature, respiratory rate, water intake and hematocrit in steers exposed to environmental temperatures of 40, 65 or 90°F.

Variable	Treatment Temperature °F	Day of the experiment in relation to the day of the temperature change (Day 0)				
		Day -1	Day 0	Day 1	Day 2	Day 3
Rectal temperature (°F)	40	101.9±.2[a]	102.2±.3	101.4±.1	101.8±.4	102.0±.3
	65	102.2±.3	102.1±.5	101.8±.2	102.2±.4	102.5±.4
	90	101.9±.1	102.7±.4	104.2±.3	105.4±.3	105.7±.3
Respiratory rate (Breaths/min)	40	16 ± 2	26 ± 3	12 ± 1	14 ± 2	14 ± 2
	65	19 ± 2	39 ± 9	37 ± 2	32 ± 5	39 ± 5
	90	22 ± 2	43 ± 8	96 ± 4	83 ±10	82 ± 7
Daily water intake (L/day)	40	8.3±.6	7.2±.3	4.1±.6	7.9±.4	6.6±.7
	65	8.4±.9	6.5±.4	7.2±.4	8.3±.4	9.4±1.3
	90	8.4±.6	9.6±.6	11.6±.4	13.1±.7	13.1±.5
Hematocrit (%RBC)	40	----	31 ± 1	31 ± 1	31 ± 1	29 ± 1
	65	----	31 ± 1	27 ± 1	28 ± 1	26 ± 1
	90	----	32 ± 1	28 ± 1	27 ± 1	26 ± 1

[a] $\bar{x}$± S.E. for eight steers.

90°F, rectal temperature increased from a pre-treatment average of 101.9±.1 to 105.7±.3°F after exposure for 3 days. The rectal temperatures of these steers had returned to normal by 3 days after the end of the replicate. Respiratory rate (breaths per min) followed a pattern similar to that of rectal temperature and the rate increased in the steers exposed to the hot environment (Table 1; $P<.01$). After exposure to the hot environment for only 1 day, the respiratory rate was 3 to 4-fold greater than the pre-exposure rate and the rate of control steers (65°F). Minton *et al.*, 1979, reported similar changes in respiratory rates and rectal temperatures in beef bulls exposed to increased ambient temperatures. Respiratory rates were reduced in the steers exposed to 40°F compared to steers at 65°F ($P<.05$) but rectal temperatures were not significantly different between these two groups.

The average daily water consumption increased in steers after exposure to the hot environment ($P<.01$). The daily water intake increased from 8 to 13 liters after exposure to 90°F for several days (Table 1). Feed intake was kept relatively constant over all treatment groups with animals restricted to only 7 lb of feed per day. Only two steers in the 90°F group had refused feed during the experiment with a total of 3.5 lb and 8 lb remaining at the end of the replicate.

The hematocrit decreased in all treatment groups throughout the experiment (Table 1; $P<.01$). The decrease in the hematocrit in all treatment groups may have been caused by a total of 500 ml of blood withdrawn from each animal during the 4 days of the trial. However, the decrease in the hematocrit was most evident in the steers exposed to the hot environment ($P<.05$). The decrease in hematocrit after exposure to the hot environment may be related to the increase in water intake causing an increase in extracellular volume. The increase in respiratory rates in these steers is a compensatory mechanism to maintain body temperature by evaporation through the respiratory tract. The loss of water through the respiratory tract was apparently less than the increase in water intake, thus a decrease in hematocrit. The increae in extracellular fluid after exposure to high environmental temperature for several days has been reported in other species (see Collins and Weiner, 1968, for review).

Future Plans

To ascertain how the pituitary-thyroid axis responds at different environmental temperatures, steers were challenged with thyrotropin releasing hormone (50 ug/steer) on the day the temperature was changed and 3 days later. Frequent blood samples were collected via a jugular cannula to monitor thyroxine and triiodothyronine. Analysis of thyroxine by radioimmunoassay is currently in progress.

Literature Cited

Collins, K. J. and J. S. Weiner. 1968. Physiological Reviews 48:785.

Minton, J. E., R. P. Wettemann, D. C. Meyerhoeffer and E. J. Turman. 1979. Okla. Agr. Exp. Sta. Misc. Pub. 140:150.