

Effect of Thyrotropin-Releasing Hormone (TRH) on Bovine Plasma Thyroxine Levels at 18.5 and 35 C¹ (38709)

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The depressing effect of high environmental temperature on thyroid function in cattle has been well established (1-3). Yousef (4) reported that high environmental temperature decreased thyroid activity, heat production, feed intake, milk production, and increased rectal temperatures. The data also indicated a relationship between metabolic rate and rate of production, with thyroxine having a calorogenic effect in cattle under thermoneutral conditions and high ambient temperatures. Evidence from this laboratory may also suggest that many lactation, growth, and reproductive problems in bovine may arise from pituitary hormonal depression in heat or tropical conditions (5). Systemic infusion of TRH has been shown to be effective in short term elevation of basal thyroxine levels in bovine under thermoneutral conditions (6, 7). Therefore, the primary objective of this study was to determine the effect of intramuscular (IM) injection of thyrotropin-releasing hormone [(TRH) (400 μ g, daily)] on plasma thyroxine levels at 18.5° and 35°, as part of an overall long range objective to determine if thermoneutral hormonal levels may be sustained under environmental heat or tropical conditions by hypothalamic releasing factors.

Materials and Methods. Six mature non-lactating Holstein cows were acclimated to a constant temperature of 18°, 50% RH for 7 days in the Missouri Climatic Laboratory. The test procedures for 18.5 and 35° treatment exposure were as follows: a sham period (saline injection) of 10 days preceded and followed each 14-day TRH²

treatment period. Each cow was injected with 400 μ g TRH (or saline in sham periods) IM daily at 1200-1230 hr. Blood samples were collected via tail vein before each TRH or saline injection treatment. The animals received feed and water *ad libitum* throughout all treatment periods. Total plasma thyroxine levels were determined by a radioimmunoassay (8) procedure and all statistical analyses were performed by analysis of variance and protected Least Significant Difference test.

Results. Table I and Fig. 1 show the results of TRH (IM) administration on plasma thyroxine levels at 18.5°. On day 4 following TRH injection the highest T₄ levels were observed (119.2 \pm 9.4) which was significantly ($P < 0.01$) elevated as compared to the sham injection period. On day 7 values were still elevated ($P < 0.05$) as compared to sham period (82.8 ng/ml vs 106, respectively). From day 7 to 14 plasma thyroxine levels were declining but were elevated 18% (N.S.) as compared to the pre-TRH period. The post-TRH sham period values were nonsignificantly elevated 15% compared to pre-TRH sham period.

Figure 1 and Table II show the results of TRH (400 μ g daily) administration on thyroxine values at 35°. The effect of 35° was a 16% ($P < 0.05$) depression of plasma thyroxine on days 2-10 of the pre-TRH treatment period compared to 18.5° values. These depressed values due to thermal exposure have been well documented by other investigators (1-3); therefore, day 5 values at 35° as well as the 18.5° treatment values were used to determine the effect of TRH at 35° (Table II). Using day 5 values at 35° the effect of TRH was a significant elevation ($P < 0.05$) of plasma thyroxine levels on days 1-6 of TRH treatment. On day 10 of TRH injection, values were de-

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pressed (Fig. 2) as compared to pre-TRH treatment (35°), and other values within the TRH treatment period. On day 1-7 of the post-TRH treatment values were depressed by 10% compared to day 5 of the pre-TRH period (35°). Using day 0 values (18.5° treatment values) the effect of TRH was to sustain these levels (18.5° treatment levels) on days 1-6 of TRH treatment at 35°, which would normally be depressed due to heat treatment.

Discussion. The results of this study indicate that IM administration of 400 µg daily of TRH is effective in elevating plasma thyroxine concentration at both thermal neutral and thermal exposure condition. At 18.5° the levels were increased for 7 days, but this response was not sustained for the entire 14-day treatment period. The

responsiveness of thyroid and pituitary glands to exogenous TRH appears to diminish after 7 days of treatment. The thyroxine levels were elevated somewhat in the latter stages of TRH treatment and in the post-TRH treatment period, but this elevation was observed not to be different from the pre-TRH treatment period. It is possible that the elevation of plasma thyroxine levels were not sustained throughout the latter TRH treatment period because the previous high thyroxine levels due to TRH administration had a suppressive effect on TSH secretion (9, 10) exerted at the level of the anterior pituitary (11).

TABLE I. PERCENT CHANGE OF PLASMA THYROXINE LEVELS AT 18.5° FOLLOWING INTRAMUSCULAR DAILY INJECTION OF 400 µg TRH.

| Treatment | T ₄ ng/ml | n | % change |
|---------------------|----------------------|----|----------|
| Days 1-10 (pre-TRH) | 82.8 | 18 | — |
| Days 1-7 (TRH) | 107.3 | 18 | ↑30% |
| Days 7-13 (TRH) | 97.6 | 18 | ↑18% |
| Days 1-7 (post-TRH) | 95.1 | 18 | ↑15% |

TABLE II. PERCENT CHANGE OF PLASMA THYROXINE LEVELS AT 35° FOLLOWING INTRAMUSCULAR DAILY INJECTION OF 400 µg TRH.

| Treatment | Day 0 (14 days at 18.5°) | Day 5 (5 days at 35°) |
|---------------------|--------------------------|-----------------------|
| | % Change | % Change |
| Days 1-8 (pre-TRH) | ↓16% | — |
| Days 1-6 (TRH) | ↑2% | ↑21% |
| Days 6-11 (TRH) | ↓16% | no change |
| Days 1-7 (post-TRH) | ↓24% | ↓10% |

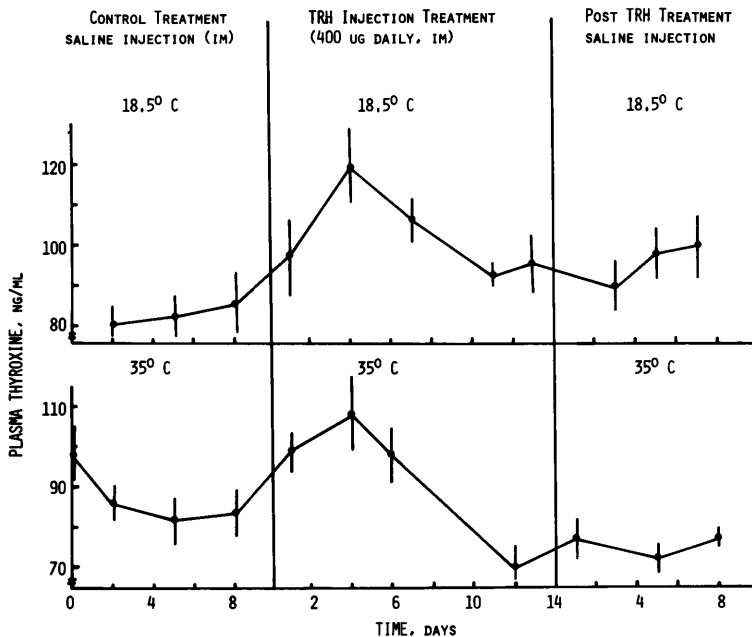


FIG. 1. The effect of TRH (400 µg im daily) administration on plasma thyroxine levels at 18.5 and 35°.

The finding that TRH is effective in elevating plasma thyroxine levels under high thermal conditions is consistent with a short-term experiment of Tal and Sulman (12) in rats, but this study not only shows responsiveness to TRH under thermal conditions, but also shows this responsiveness is viable for a period of 6 days. After 6 days of TRH treatment at 35° the exogenous TRH was ineffective in elevating plasma thyroxine as compared to the pre-TRH treatment with values in the latter stages of TRH treatment period and post-TRH treatment period being actually lower than pre-TRH treatment values at 35°. These depressed plasma thyroxine levels in the latter stages of TRH treatment and post-TRH treatment periods can possibly be explained by the additive thermal effects on thyroid activity and/or the previous high plasma levels of thyroxine diminishing the effectiveness of exogenous TRH. Therefore the results of this study indicate that repetitive administration of TRH results in diminished responsiveness after a time to exogenous TRH in cattle with these diminished effects of TRH more pronounced under conditions of thermal exposure. Further studies are warranted to determine optimal TRH administration (dose and time) for increased sustained elevation of bovine thyroxine levels under thermoneutral and thermal conditions.

Summary. Six mature nonlactating Holstein cows were subjected to a test procedure of a sham period (saline injection) of 10 days that preceded and followed each 14 day TRH treatment period at 18.5 and 35°.

The objective of this study was to determine the effect of intramuscular injection of TRH (400 µg daily) on bovine plasma thyroxine levels at 18.5 and 35°. The results indicate that im administration of TRH is effective in elevating plasma thyroxine levels at both 18.5 and 35°, but the response is diminished after 7 days at 18.5° and ineffective in sustaining or elevating plasma thyroxine levels in cattle after 6 days of TRH administration at 35°.

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