

TEMPORAL PATTERNS OF GROWTH HORMONE, PROLACTIN AND THYROTROPIN SECRETION IN TARGHEE RAMS SELECTED FOR RATE AND EFFICIENCY OF GAIN¹

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Summary

Thirteen Targhee rams selected for rate and efficiency of gain for 4 yr (1.5 generations) were compared with 10 rams from a Targhee line with no selection for over 20 yr to determine if selection for these traits would be associated with changes in the secretion of growth hormone (GH), thyrotropin (TSH) and/or prolactin (PRL). Selected rams exhibited greater birth weight, average daily gain (ADG) and feed consumed/day during a 6-wk individual feeding regimen, and exhibited greater overall ADG during a 16-wk feeding trial as compared with the unselected rams. Temporal blood plasma samples were collected at 15-min intervals for 8 h from each of the 23 rams for hormone analysis. Selected rams exhibited greater overall mean GH ($6.1 \pm .4$ vs $4.6 \pm .5$ ng/ml), overall mean TSH (8.6 ± 1.2 vs $6.2 \pm .7$ ng/ml) and baseline mean TSH (8.0 ± 1.1 vs $5.6 \pm .5$ ng/ml) than the unselected rams. Although the adjusted GH spike amplitude value was

higher in the selected line (12.1 ± 3.0 vs $7.4 \pm .8$ ng/ml), this difference was not significant. No differences were observed with any of the variables of PRL secretion. In addition, there were no significant correlations between any of the hormone variables and any of the feed or gain data. These data support the hypothesis that Targhee rams selected for rate and efficiency of gain exhibit higher plasma levels of GH and TSH than unselected rams of the same breed.

(Key Words: Rams, Selection, Growth Hormone, Prolactin, Thyrotropin.)

Introduction

Although it has long been thought that growth hormone (GH) is the primary growth regulating hormone, attempts to correlate plasma or serum GH to measures of growth in domestic animals have met with mixed results. For example, correlations between plasma GH and weight gain tended to be negative in beef steers (Trenkle, 1970) and Holstein heifers (Purchas et al., 1971). In contrast, Purchas et al. (1970) reported that plasma GH concentration was significantly and positively correlated with "specific growth rate" and plasma GH content was significantly and positively correlated with body weight at slaughter in young bulls. Similarly, measures of "GH status" were positively correlated to carcass muscle and muscle RNA in cattle (Trenkle and Topel, 1978). Most of the previous studies have been conducted using either single or infrequent blood samples to reflect blood concentrations of GH. More recently, it has been demonstrated that frequent sequential blood samples must be collected to accurately assess blood GH concen-

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tration because of the pulsatile nature of GH secretion in cattle (Christian et al., 1978) and sheep (Davis et al., 1977). Using this approach to reexamine the relationship between growth and measures of plasma GH, it was observed that overall mean and baseline mean plasma GH were higher in Simmental than in Hereford bull calves and that overall and baseline mean GH were positively (though nonsignificantly) correlated to average daily gain (ADG) and body weight (Ohlson et al., 1981).

The present experiment was designed to examine the relationship of growth rate and efficiency with measures of secretion of GH, prolactin (PRL) and thyrotropin (TSH) in ram lambs from a line of Targhee sheep that had been selected for rate and efficiency of gain and a control nonselected line. The hypothesis being tested was that, if GH, PRL and/or TSH were the principal mediator(s) of increased growth rate in the selected line, then these ram lambs should exhibit greater measures of hormone secretion than the nonselected lambs.

Materials and Methods

Animals. Twenty-three Targhee rams were obtained from the USDA, U.S. Sheep Experiment Station, Dubois, Idaho. Ten rams, representing six sires, were chosen randomly from a line that had been maintained without selection for over 20 yr. The remaining 13 rams, representing five sires, were the top performers chosen from a line after 4 yr (1.5 generations) of selection for ADG and efficiency of gain (EOG). The criteria for selection of the rams used for this study were based on the results of yearly feeding trials. The feeding trial for 1980 was conducted as follows: All rams within the selected line were born in April, weaned as a group on July 7 then fed a diet that consisted of 37% barley (IFN 4-00-549) and 63% alfalfa (IFN 1-00-063). From August 12 to September 23 all rams (average age = 17 wk) were individually fed the barley-alfalfa diet ad libitum. On September 24 the rams were removed from the individual feeding regimen and placed on a group feeding regimen for an additional 6 wk. During this period, all rams were fed alfalfa (IFN 1-00-063) ad libitum. All rams were weighed at biweekly intervals during the individual and group feeding periods and were evaluated on the basis of ADG and feed to gain ratio during the 6-wk individual feeding period and ADG at the end of the 16-wk period.

Bleeding Regimen. In December, 1980, the 23 rams were transported to facilities located at the University of Idaho. Upon arrival, the rams were immediately placed indoors into individual metabolism crates that restricted lateral and circular movements. The temperature was thermostatically controlled at 13 C and lighting was set mechanically to provide 10 h of light and 14 h of darkness during each 24-h period. Each ram was fed 2.2 kg alfalfa/d (IFN 1-00-059) and water was provided ad libitum. After a 2-wk acclimation period, a jugular cannula was inserted into each ram (under sodium pentothal anesthesia) to facilitate blood sampling. On the following day, 8-ml blood samples were taken from each ram at 15-min intervals from 0800 to 1600 h. Blood samples were dispensed into tubes containing 100 units of heparin and were stored overnight at 4 C. The plasma from each sample was then collected and frozen at -20 C until time of assay.

Assay Procedures. Plasma samples were assayed for GH, PRL and TSH by radioimmunoassay (RIA) techniques described previously (Davis et al., 1971; Davis, 1972; Borger and Davis, 1974, respectively). The reference standard hormones used were Wilhelmi ovine GH, NIH-P-S10 and NIH-TSH-S6. Mean RIA sensitivities for GH, PRL and TSH were .68, .58 and .67 ng/ml, respectively. Interassay and intraassay mean covariance values were 8.6 and 4.9%, 11.9 and 5.8%, and 4.9 and 1.8%, respectively, for GH, PRL and TSH.

Statistical Analysis. Least-squares analysis of variance (Harvey, 1975) was computed using the General Linear Models procedure (SAS 1979). The hormone variables were logarithmically transformed before analysis. This transformation was required to equalize the variances that were proportional to the squares of the treatment means (Steel and Torrie, 1960). The mathematical model used was:

$$Y_{ij} = \mu + T_i + e_{ij},$$

where

Y_{ij} = observed response;

μ = overall mean;

T_i = the effect of the i^{th} method of selection, either from a Targhee line selected for ADG or EOG or from a random-bred Targhee line, and

e_{ij} = effect of the j^{th} ram on the i^{th} method of selection, assumed to be randomly and independently distributed.

TABLE 1. ANALYSIS OF GROWTH HORMONE, PROLACTIN AND THYROTROPIN SECRETORY PATTERNS IN UNSELECTED AND SELECTED TARGHEE RAMS^a

Variable	Growth hormone		Prolactin		Thyrotropin	
	Unselected	Selected	Unselected	Selected	Unselected	Selected
Overall, ng/ml	4.6 ± .5	6.1 ± .4 ^c	59 ± 4	62 ± 5	6.2 ± .7	8.6 ± 1.2 ^d
Baseline, ng/ml	3.2 ± .5	3.7 ± .3	46 ± 4	46 ± 5	5.6 ± .5	8.0 ± 1.1 ^d
Amplitude, ^b ng/ml	7.4 ± .8	12.1 ± 3.0	39 ± 5	39 ± 3	3.2 ± .6	3.7 ± .5
Frequency, no./8 h	3.2 ± .3	3.7 ± .2	3.0 ± .3	3.3 ± .2	2.3 ± .3	2.1 ± .2

^aValues represent means ± SE.

^bAmplitude represents mean adjusted amplitude (episode amplitude–baseline).

^cDifferent ($P < .02$) from value for unselected line.

^dDifferent ($P < .05$) from value for unselected line.

Mean overall hormone concentration, mean baseline hormone concentration, adjusted spike amplitude and frequency were calculated separately for GH, PRL and TSH using a method similar to that of Christian et al. (1978) with further modifications using the Statistical Analysis System (SAS, 1979). These 12 variables were used in the analysis.

The growth and feed consumption data were also analyzed by least-squares analysis of variance as previously described (Harvey, 1975). The variables included 6-wk ADG (kg/d), 6-wk feed/d (kg), 6-wk feed conversion (feed/gain) and 16-wk ADG (kg/d). Correlations were computed by methods described previously (Steel and Torrie, 1960).

Results

Baseline mean GH concentration, mean GH amplitude, mean GH spike frequency, all of the

PRL variables and the TSH mean amplitude and spike frequency were not different ($P > .05$) between lines. However, the overall mean GH concentration ($P < .02$) as well as the overall and baseline mean TSH concentrations ($P < .05$) were higher in the selected rams (table 1).

The selected rams exhibited greater mean birth weight ($P < .01$) and greater mean body weight (BW) at 270 d of age ($P < .01$) than did the unselected rams (table 2). In addition, the overall mean BW of both Targhee lines (at 270 d of age) was positively ($P < .05$) correlated ($r = .62$) to birth weight. However, no correlations existed between any of the hormone variables and birth weight ($P > .05$; data not shown). The overall mean GH concentrations, but none of the TSH variables, for both ram lines were negatively correlated (within line) to BW at 270 d of age ($r = -.38$ and $r = -.32$ for the unselected and selected rams, respectively).

Correlation coefficients were computed for the significant variables of hormone secretion (e.g., mean overall GH, mean overall TSH and mean baseline TSH) and the growth and feed efficiency variables. Although mean overall GH of the selected rams was positively correlated ($r = .43$) to 16-wk ADG, this coefficient and all others tested were not significant.

Analysis of the variables collected during the 6-wk individual feeding period (table 3) revealed that the mean ADG ($P < .02$), as well as the mean feed consumption ($P < .01$), were higher for the selected rams. In addition, the selected rams had a higher ($P < .001$) mean 16-wk ADG than unselected rams. No differences ($P > .05$) were observed with respect to 6-wk mean feed to gain ratios between lines.

TABLE 2. ANALYSIS OF TARGHEE BIRTH WEIGHT, 270-DAY WEIGHT AND AGE WHEN STUDIED^a

Variable	Unselected	Selected
Birth wt, kg	4.7 ± .2	5.6 ± .2 ^b
Wt at 270 d, kg ^c	53.5 ± 1.5	60.6 ± 1.4 ^b
Age at cannulation, d	270 ± 1.0	268 ± 2.0

^aValues represent means ± SE.

^bDifferent ($P < .01$) from unselected line.

^cMean weight at 270 d was positively ($P < .05$) correlated to mean birth weight ($r = .62$).

TABLE 3. TARGHEE RAM FEED AND GAIN DATA COMPILED DURING THE 1980 FEEDING TRIAL CONDUCTED AT THE USDA, U.S. SHEEP EXPERIMENT STATION, DUBOIS, IDAHO^a

Type	6-wk individual feeding period (August 12 to September 12)			16-wk rate of gain, kg/d
	ADG, kg/d	Feed/day, kg	Feed/gain	
Unselected	.30 ± .02	2.0 ± .13	7.15 ± .7	.27 ± .01
Selected	.39 ± .04 ^b	2.5 ± .06 ^c	6.49 ± .3	.36 ± .02 ^d

^aValues represent means ± SE.

^bDifferent ($P < .02$) from value for unselected line.

^cDifferent ($P < .01$) from value for unselected line.

^dDifferent ($P < .001$) from value for unselected line.

Discussion

The between line differences observed (table 1) in the overall mean GH concentration, as well as the overall and baseline mean TSH concentrations, were probably not induced by external factors because all rams were exposed to a similar environment throughout their lifetime. Age-associated variations in the secretory patterns of GH, PRL and TSH in rams (Morrison et al., 1981) can be discounted in the present study because the ages of both lines of rams were similar ($P > .05$) at the time when blood samples were drawn (table 2).

Correlative data between various anabolic hormones and rate of weight gains (growth in body size) have been reported previously for cattle. Purchas et al. (1970) reported that plasma GH concentration, pituitary GH concentration and pituitary GH/unit BW were positively correlated to growth rate in Holstein bulls. Trenkle (1970) found that finishing steers, fed 10 mg of diethylstilbestrol \cdot animal⁻¹ \cdot d⁻¹ for 142 d before slaughter, had significantly higher ADG and higher plasma GH concentrations than did control steers. In addition, Trenkle and Topel (1978) reported that the plasma metabolic clearance rate of GH was positively correlated with daily gains in crossbred steers. However, Keller et al. (1979) stated that, although plasma GH levels and plasma GH to BW ratios were significantly greater in Angus cattle than in Hereford cattle (at all sampling dates), no correlations existed between plasma GH values and BW for either breed. Furthermore, Ohlson et al. (1981) found no correlations between any GH variable and BW in either

Hereford or Simmental breeds of cattle. There have been few studies to document correlations (or lack thereof) of this type with specific breeds of domestic animals.

These data demonstrate that selection for growth rate and efficiency of gain also results in a greater ability to secrete GH and TSH. This observation, however, does not prove that the relationship is cause and effect. It would be of considerable interest to determine if selection for ability to secrete GH was also associated with an increase in growth rate and(or) efficiency of gain.

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