GROWTH HORMONE SECRETION RATES IN CATTLE

ALLEN TRENKLE

Iowa State University of Science and Technology, Ames 2 50010

Based upon the growth hormone (GH) content in the anterior pituitary, Baird, Nalbandov and Norton (1952) proposed that reduced growth rate and growth stasis of pigs was due to a gradual dilution of the hormone in body tissues with aging. A reduction with aging in the amount of GH in the pituitary per unit of body weight has also been observed in cattle (Armstrong and Hansel, 1956; Curl et al., 1968). Measurements of plasma GH levels in humans (Glick et al., 1965) and in cattle (Trenkle, 1970), however, have indicated that mature individuals have plasma levels of the hormone within the lower range of the actively growing young. Plasma levels of GH are determined by the amount of the hormone secreted and the rate of clearance of the hormone from circulation. If there is considerable variation in the rate of clearance of the hormone, plasma levels would not be indicative of secretion. While the present experiments were in progress, Yousef et al. (1969) have published data on GH secretion in Holstein cows.

The objectives of the two experiments reported in this paper were to measure plasma levels of GH and rate of clearance of GH from circulation in cattle of different ages and to use these two measurements to calculate secretion rates of GH.

Materials and Methods

Clearance of GH from the circulation in cattle was obtained by measuring plasma levels of the hormone after injection of exogenous GH. A catheter was placed in the jugular vein of each animal several hours before the experiment. Four blood samples were taken, during the 30-min. period before GH was injected, to establish basal plasma GH levels. The bovine GH was dissolved in 0.85% NaCl and administered through the indwelling catheter. The catheter was rinsed with 0.85% NaCl, and four to six blood samples were taken during the next 40 to 60 minutes. The decrease in concentration of GH after injection of the hormone fit a straight line when the logarithms of plasma GH levels were plotted against time (min.). The method of least squares was used to calculate a regression equation from which the fractional turnover rate (K) was obtained for each animal. The line was extrapolated to zero time to obtain the theoretical concentration of plasma GH after the exogenous GH was completely distributed in body fluids, but before any had been lost. The difference between plasma levels at zero time and basal plasma levels of GH was used to calculate the volume of distribution of the hormone (VGH). Secretion rate of GH was obtained from: VGH x K x Basal GH. Concentrations of GH in plasma and in the injected solutions were measured by the solid-phase radioimmunoassay described previously (Trenkle, 1970). Bovine thyroid-stimulating hormone, interstitial-cell-stimulating hormone, prolactin and plasma from a hypophysectomized calf did not react in this assay. Sequential dilutions of bovine plasma and extracts of bovine anterior pituitary glands paralleled the standard curve obtained with purified bovine GH. The GH standard was obtained from Dr. C. H. Li (Li, 1954).

The first study was conducted with two Hereford and three Holstein bull calves about 3 months old, with an average body weight of 66 kilograms. The calves were housed indoors and were fed twice daily a liquid diet containing a milk replacer. The GH clearance rate was measured 5 hr. after feeding. Each animal was injected with 0.4 mg of bovine GH.

The second study was conducted three different times with four Hereford bulls and four Hereford heifers. The first measurement of the clearance rate was made when the bulls were 7 months old, with an average body weight of 223 kg, and the heifers were 8 months old, with an average body weight of 227 kilograms. The animals were housed indoors and were twice daily fed a diet containing 69% cracked corn, 20% chopped alfalfa hay, 5% molasses, 5% soybean meal and 1% minerals. Each animal was injected with 0.4 mg...
of bovine GH 2.5 hr. after feeding. The second and third measurements were made when the bulls were 14 and 16 months old, with average weights of 388 and 438 kg, and when the heifers were 15 and 17 months old, with average weights of 356 and 408 kilograms. The animals were housed in an open shed and fed daily a full feed of cracked corn, 0.9 kg ground corn cobs and 0.45 kg soybean meal. The experiments were conducted about 5 hr. after feeding and after each animal was injected with 3.0 mg of bovine GH.

Results

Plasma levels and clearance rates of GH in the young bull calves used in the first study are shown in table 1. Exogenous GH was cleared from circulation with a mean half-life of 21.8 min., plasma GH levels were 18 ng/ml, and the calculated secretion rate was 47.0 μg/kg/day. No differences were observed in any of the measurements that could be attributed to breed of the bull calves; thus, breeds were not differentiated in table 1.

The data obtained from the bulls and heifers used in the second study are shown in table 2. Plasma GH levels were higher (P<.05) and fractional turnover rates lower (P<.01) in the bulls as compared with the heifers. There were no significant differences in volume of distribution or rate of secretion of GH per unit of body weight between the bulls and heifers.

There were no consistent changes in either plasma levels or secretion rates of GH in the bulls or heifers used in the second study that could be related to age. Figure 1 shows the relationship between level of plasma GH and secretion rate for the animals used in these studies. The correlation coefficients between plasma levels and secretion of the hormone were 0.99 (P<.01) for the calves, 0.70 (P<.01) for the heifers.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean*</th>
<th>S.E.~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body wt., kg</td>
<td>66.3</td>
<td>6.1</td>
</tr>
<tr>
<td>Plasma GH, ng/ml</td>
<td>18.0</td>
<td>3.7</td>
</tr>
<tr>
<td>Turnover, K/hr.</td>
<td>1.95</td>
<td>0.13</td>
</tr>
<tr>
<td>Half-life, min.</td>
<td>21.8</td>
<td>1.5</td>
</tr>
<tr>
<td>% of body weight</td>
<td>5.6</td>
<td>0.4</td>
</tr>
<tr>
<td>GH secretion mg/day</td>
<td>3.3</td>
<td>0.9</td>
</tr>
<tr>
<td>μg/kg/day</td>
<td>47.0</td>
<td>10.4</td>
</tr>
</tbody>
</table>

* Mean of six observations.

** TABLE 2. GROWTH HORMONE SECRETION RATE AND ITS COMPONENTS IN BULLS AND HEIFERS**

<table>
<thead>
<tr>
<th>Period</th>
<th>Body wt. kg</th>
<th>Plasma GH, ng/ml</th>
<th>Turnover, K/hr.</th>
<th>Half-life, min.</th>
<th>% of body weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>223.5 ± 8.7</td>
<td>6.8 ± 0.7</td>
<td>1.40 ± 0.06</td>
<td>3.0 ± 0.15</td>
<td>5.2 ± 0.3</td>
</tr>
<tr>
<td>II</td>
<td>251.3 ± 5.9</td>
<td>6.2 ± 0.7</td>
<td>1.91 ± 0.04</td>
<td>3.1 ± 0.3</td>
<td>3.8 ± 0.5</td>
</tr>
<tr>
<td>III</td>
<td>356.0 ± 4.5</td>
<td>5.4 ± 0.7</td>
<td>2.22 ± 0.08</td>
<td>3.8 ± 0.5</td>
<td>2.6 ± 0.2</td>
</tr>
</tbody>
</table>

* Number of observations.

~ Standard error.
Fig. 1. Relationship between growth hormone secretion and plasma levels of growth hormone in cattle. • Calves, • Bulls and ▲ Heifers.

Discussion

The concentration of GH in plasma and the secretion rate per unit of body weight were higher in the calves used in the first study (table 1) as compared with the older animals used in the second study (table 2). In another study (Trenkle, 1970), calves less than 8 weeks old had higher levels of plasma GH than mature cows; and by 20 weeks, levels of the hormone in plasma had decreased to a point similar to that of the cows. Since clearance of GH from the plasma was relatively constant at all ages; but in the heifers, there was a trend towards a gradual increase in turnover rate with maturity.

Summary

Two experiments were conducted to measure plasma levels and clearance rates of growth hormone in cattle. Clearance from circulation was obtained by measuring plasma levels of the hormone after injection of exo-
genous bovine growth hormone. A growth hormone secretion rate was calculated from volume of distribution, clearance rate and basal plasma level of the hormone. In five 3-month-old bull calves, average values were 18.0 ng/ml for growth hormone plasma levels, 21.8 min. for half-life and 47.0 μg/kg/day for rate of secretion. In four bulls and four heifers studied during three periods when the animals were 7 to 17 months old, average plasma growth hormone levels were 7.1 and 4.7 ng/ml for the bulls and heifers. In bulls and heifers, average values were 24.7 and 17.8 min. for the half-life and 9.8 and 7.6 μg/kg/day for the secretion rate. A correlation coefficient of 0.97 was observed between secretion rates and plasma levels of growth hormone.

**Literature Cited**


