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Relationship between blood plasma IGF-1 and GH concentrations and growth of Holstein steers

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ABSTRACT. Insulin-like growth factor-1 (IGF-1) and growth hormone (GH) have been studied as indicators of growth potential in beef cattle, but these relationships had not been studied previously in Holstein steers. In this case 12 calves weaned at a mean age of 45 d and body weight (BW) of 54.6 kg were used to obtain, every 28 d during a 336-day experiment, BW data and blood samples. Ten blood samples collected at 30-minute intervals, from 0800 to 1300 h were mixed together and analyzed for concentration of IGF-1 and GH by radio-immuno assay. Linear regression and correlation analyses were performed to determine the relationship between average daily gain (ADG) and BW, and plasma IGF-1 and GH concentrations. The correlations between plasma IGF-1 and ADG or BW were consistently positive (0.47 and 0.48), but those between GH and ADG or BW were negative (-0.31 and -0.37, respectively). Plasma concentration of IGF-1 explained 24% of the variation in ADG, but GH explained only about 10%. Concentration of IGF-1 showed a strong relationship with BW (R^2 = 0.41) throughout a 336-day period of growth. These data indicate that plasma IGF-1 may be useful for predicting performance of Holstein steers.

Key words: GH, Growth prediction, Holstein steers, IGF-1

Relación entre las concentraciones de IGF-1 y GH en plasma sanguíneo y el crecimiento de novillos Holstein

RESUMEN. El factor de crecimiento ligado a la insulina (IGF-1) y la hormona de crecimiento (GH) se han estudiado como indicadores del potencial de crecimiento en bovinos de raza para carne, pero la relación entre éstos con el crecimiento y el desarrollo de novillos Holstein no se había estudiado previamente. En el presente trabajo 12 becerros de edad y peso corporal (BW) promedio de 45 d y 54.6 kg se usaron para obtener BW y muestras de sangre cada 28 d durante un experimento de 336 d. Se colectaron 10 muestras en intervalos de 30 min a partir de 0800 hasta 1300 h en cada fecha del muestreo. Las muestras del mismo día y animal se mezclaron y se analizaron para concentraciones de IGF-1 por la técnica de Radio Inmune Ensayo (RIA). Para determinar la relación de ganancia diaria promedio (ADG) y BW con las concentraciones plasmáticas de IGF-1 y GH (Conc. IGF-1 y Conc. GH), se aplicó análisis de regresión lineal y correlación simple. Las correlaciones entre Conc. IGF-1 y ADG o BW fueron consistentemente positivas (0.47 y 0.48), pero las de Conc. GH con ADG y BW fueron negativas (-0.31 y -0.37, respectivamente). La Conc. IGF-1 explicó 24% de la variación en ADG; en contraste, la Conc. GH explicó solamente cerca de 10%. La Conc. IGF-1 mostró una fuerte relación con BW (R^2 = 0.41) durante los 356 d de crecimiento. Estos datos indican que aquella puede ser un predictor útil del potencial de crecimiento en novillos Holstein.

Palabras clave: GH, IGF-1, Novillos Holstein, Predicción de crecimiento

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Introduction

Because IGF-I mediates many of the growth-promoting effects of GH and regulates postnatal growth and development, circulating IGF-I has been studied as an indicator of growth potential in livestock. However, both positive and negative correlations between IGF-I and rate of gain are reported in cattle (Lund-Larsen *et al.*, 1977; Davis and Simmen, 1997; Stick *et al.*, 1998). Holstein steers are a major cattle type for use in beef production. In Northwestern Mexico and the Southern region of the United States 600,000 Holstein steers are placed in feedlots annually (Peck, 2005). Nevertheless, no information is available on growth patterns and GH and IGF plasma concentrations in Holstein steers that are typically fed for longer periods and to heavier weights than cattle of beef breeds. Therefore, the objective of this study was to relate the concentrations of GH and IGF-1 in blood plasma and growth of male Holsteins from early calfhood to the yearling stage.

Materials and Methods

This study was carried out with 12 male calves born in the dairy herd of the Instituto de Ciencias Agricolas, Universidad de Baja California, Mexico and weaned at average age and body weight (BW) of 45 d and 54.6 kg. During 100 d the calves were fed twice daily with milk and concentrate (18% CP, 0.5% fat, 8% CF with 1,000 g/t of oxytetracycline) and water was available free-choice between feedings. Thereafter, the calves were placed in a feedlot where fresh feed was provided twice daily, allowing *ad libitum* access to a diet formulated to meet NRC (1996) requirements for large-framed growing and finishing steers. The diets were estimated to contain 2.2 and 1.56 Mcal/kg (dry basis) of ENm and ENg, respectively. Individual calf weights were obtained at 28-day intervals from 1 to 336 d of age. All weights (nonshrunk) were taken 2 h after the morning feeding.

Blood samples (10 mL) were collected on Day 1 and at 28-day intervals throughout the test period. At each sampling 10 samples were collected from each calf at 30-min intervals from 0800 to 1300 h by jugular venipuncture into heparinized Vacutainer tubes (Becton Dickinson and Co., Franklin Lakes, NJ). Plasma samples from the same animal and sampling day were mixed, centrifuged (1.850 × g, 15 min, 4°C) and stored at −20°C until assayed for IGF-I and GH.

Plasma collected from individual animals at each 28-day sampling period was evaluated for IGF-I and GH concentration by RIA (Dahl *et al.*, 1997; Elsasser *et al.*, 1989).

All statistical analyses were conducted using the SAS System version 6.12 (SAS Inst. Inc., Cary, NC). Plasma IGF-I and Gh, were regressed to predict average daily gain (ADG).

Results and Discussion

Means of growth performance, GH and IGF-1 plasma concentrations are shown in Table 1. Holstein steers gained an average of 1.10 kg/d throughout the 336-day growth test. The greatest gain ($P < 0.01$) was obtained from d 168 to d 197, the period immediately following the change from a growing to a finishing diet. The IGF-1, GH concentrations and ADG varied ($P < 0.001$) over time. GH plasma concentration was highest at the beginning of the growth period (d ays 1 to 84; $P < 0.001$).

Shown in Figure 1 is a scatter plot of ADG, imposed on a graph of the live weight by time regression. The coefficient of this regression was 0.99 ($P < 0.01$).

Table 2 summarizes the partial correlations between body weight, daily gain, GH and IGF-I plasma concentrations. The correlations between ADG and IGF-I concentration were consistently positive and generally high throughout the performance test period. Similarly, Stick *et al.* (1998) found a value of $r = 0.28$ in beef cattle. The correlations between plasma GH and ADG were negative, and tended to decrease with time. A strong correlation was observed between age and IGF-1 plasma concentration ($P < 0.01$).

Table 1. Least squares means and standard deviation for age, body weight (BW), daily gain, GH and IGF-I plasma concentrations.

Item	N	X	SD	Min	Max
Age, d	156	227.3	105.49	35.00	408.00
Body weight. kg[d]	156	240.9	124.15	46.40	504.00
ADG, kg/d	155	1.10	0.41	0.00	2.30
GH,[a] nm/mL	144	11.5	3.2	3.70	16.40
IGF-1[a] nm/mL	153	307.8	97.3	60.0	516.00

[a]Hormone concentrations for each animal were calculated as the average of measurements made in ten samples collected at 28 d intervals from 45 to 336 d of age.

Regression analysis was performed using ADG, IGF-I, and GH throughout the growth testing period. As shown in Figure 2, the coefficient of this regression of ADG on plasma IGF-1 concentration was 0.2354 ($P < 0.01$), indicating that for every 1 ng/mL increase in IGF-1 concentration, ADG increased by 0.00194 kg/d, consistent with the findings of Stick *et al.* (1998). Increases in plasma IGF-1 levels are related to increased growth not only in rats (Baker *et al.*, 1991), but also in all major livestock species. Davis and Bishop (1991) found positive correlations between IGF-1 plasma concentrations and rate of gain in cattle. The present study supports the conclusion that a positive relationship exists between concentration of IGF-1 and rate of growth in Holstein steers.

Table 2. Correlation between age, body weight, daily gain, GH and IGF-I plasma concentrations

	ADGkg/d	Age, d	GHng/mL	IGFng/mL
Age, d	0.4151			
GH,ng/mL	-0.3115	-0.3354		
IGF-1, ng/mL	0.4674	0.5532	-0.2442	
Body weight, kg	0.4811	0.9753	-0.3739	0.6167

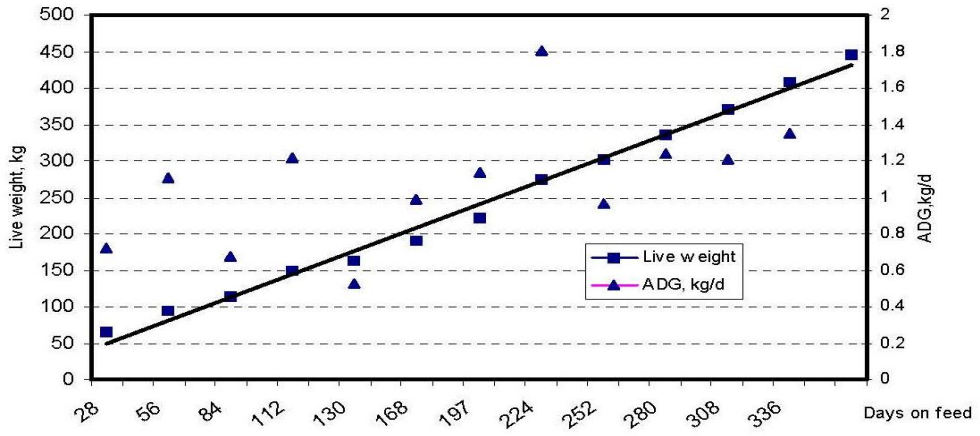

Figure 1. Live weight and average daily gain (ADG) of Holstein steers during days in feedlot

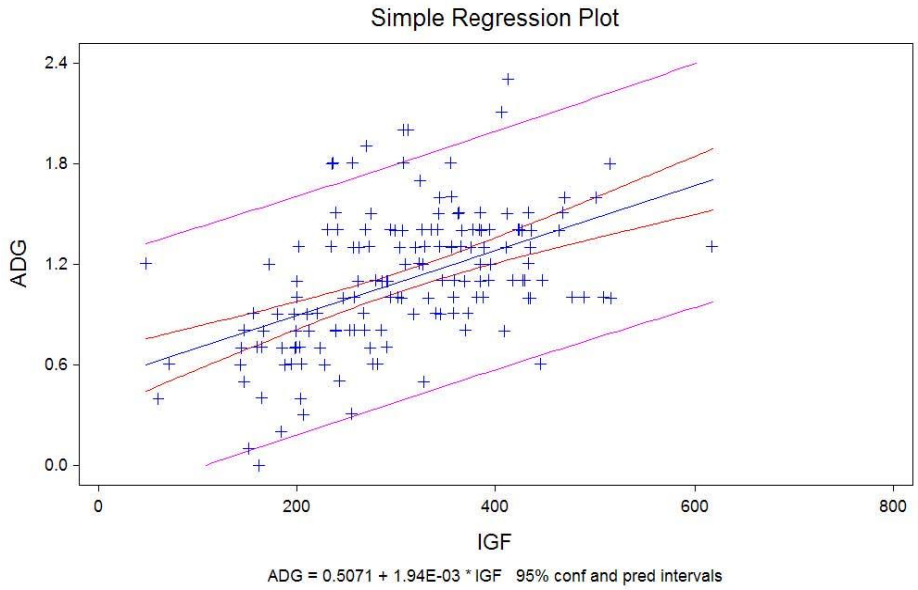

Figure 2. Plot for IGF-1 plasma concentration (ng/mL) vs ADG (kg/d)

The relationship between rate of gain and GH concentration is shown in Figure 3. Based on the model, GH plasma concentration explained only 10% of variation in ADG throughout the feedlot period ($P < 0.01$). The observed reduction in growth hormone production with increased IGF-1 concentration was surprising. A negative correlation between IGF-1 and growth hormone concentrations was also observed by Ronge *et al.* (1988) in dairy cows and Istasse *et al.* (1990) in Holstein bulls.

Implications

This study supports the hypothesis that blood plasma IGF-1 plays a role in growth performance in Holstein steers and, therefore, IGF-1, concentration data may be a useful aid in selection strategies for improved growth efficiency.

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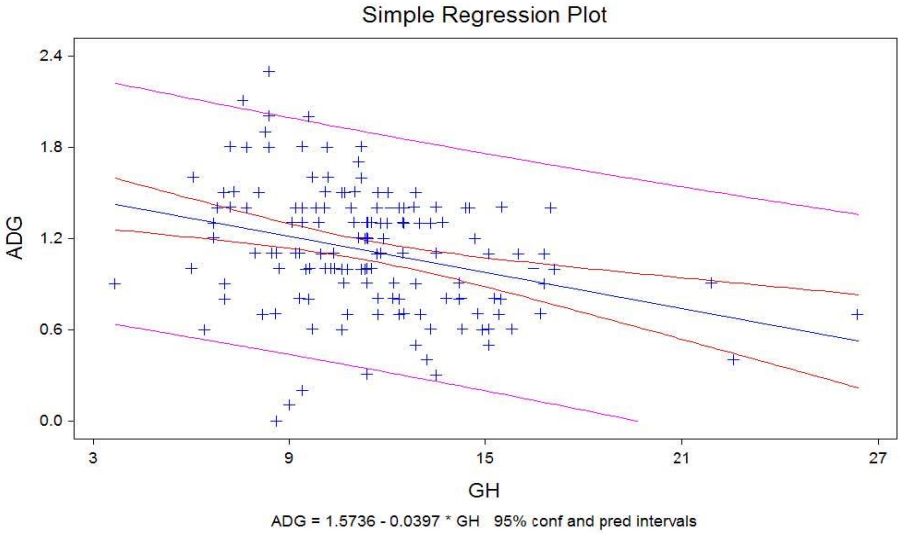

Figure 3. Plot for GH plasma concentration (ng/mL) vs ADG (kg/d)

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