Growth and onset of puberty in two genetically different lines of Holstein-Friesian heifers, selected for either heavy or light body weight

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INTRODUCTION

Heavier body weight affects dairy farm profitability through its effects on extra dietary energy requirements for maintenance and growth and on extra income from culled cattle; therefore it is now included in the new Animal Evaluation System used with New Zealand dairy cattle. The selection of two lines of Holstein-Friesian cattle began in 1989 using proven sires with either high (H) or low (L) estimated breeding value (EBV) for live weight (LW), but which were all of high genetic merit for milk solids yield. This paper reports on the onset of puberty and the pattern of growth from birth to first calving of heifers from these two genetic lines of cattle.

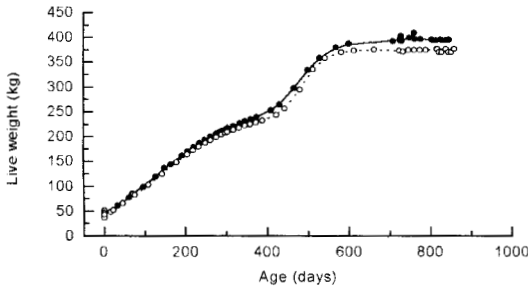
MATERIALS AND METHODS

Twenty two heifers born in 1994 (12 L and 10 H), daughters of 3 L or 3 H sires (mean±SE sire's EBV for LW 34.4 ± 2.0 and 82.9 ± 2.0 kg, respectively) were individually weighed at birth, monthly until 7 months of age, fortnightly from 7 to 11 months of age, monthly again from 11 until 3 months before first calving, at calving, and fortnightly two months after first calving. Additionally, weekly blood samples were collected from each heifer during 32 weeks starting at 7 months of age to determine onset of puberty. A diphasic logistic function of the form,

$$W_t = \frac{a_1}{[1 + e^{-k_1(t-t_1)}]} + \frac{a_2}{[1 + e^{-k_2(t-t_2)}]}$$

was fitted to the live weight-age data of each heifer by the NLIN procedure of the SAS (SAS® User's Guide: 1988) system using DUD iteration. Initial values for the parameters to start the iterative procedure were taken from the literature (Koenen, E.P.C. and Groen, A.F. (1996)). For this function W_t is live weight (kg) at age t (days), and the parameters of the growth curve are, the asymptotic live weights (kg) during the first (a_1) and second (a_2) phase of growth, the ages (days) at the first (t_1) and second (t_2) inflection point, and the maturation rates during the first (k_1) and second (k_2) phase of growth. Additionally, final asymptotic weight after two years of age was estimated for each heifer as $A=a_1+a_2$. Differences between genetic lines for the parameters of the growth curve were tested by one way analysis of variance, and the relationship between the latter and the sire's EBV for LW was investigated by means of linear regression.

FIGURE 1: Live weight of genetically heavy (—●—) or light (—○—) Holstein-Friesian heifers fitted by a diphasic logistic function. Each dot represents the Least squares average of the group for age and live weight. Average ages at puberty and at calving are indicated.



RESULTS

On average heifers from the two lines reached puberty at the same age and similar live weight as predicted from their respective growth curves (Fig. 1).

Heifers from the H line were heavier at calving, had a larger final asymptotic weight after two years of age, and reached a heavier asymptotic weight during the second phase of growth, but had a slower maturity rate during this phase than the L line heifers (Table 1).

The estimated final asymptotic weight after two years of age was positively correlated with the sire's EBV for LW (Fig. 2).

TABLE 1: Least squares means (±SE) for growth curve parameters and observed live weights (kg) and ages (days) at puberty and at first calving

Parameter	Genetic line: Heavy	Light	Significance
a_1 (kg)	250 ± 7	245 ± 7	NS
a_2 (kg)	148 ± 6	130 ± 6	*
A (kg)	398 ± 6	375 ± 6	**
t_1 (days)	136 ± 5	140 ± 5	NS
t_2 (days)	489 ± 6	487 ± 6	NS
k_1	0.01115 ± 0.00034	0.01094 ± 0.00033	NS
k_2	0.03086 ± 0.00253	0.03963 ± 0.00241	**
Puberty weight (actual)	208 ± 10	205 ± 6	NS
Puberty age	296 ± 12	294 ± 7	NS
Calving weight (actual)	386 ± 8	363 ± 7	*
Calving age	734 ± 12	733 ± 8	NS

* P < 0.05, ** P < 0.01.

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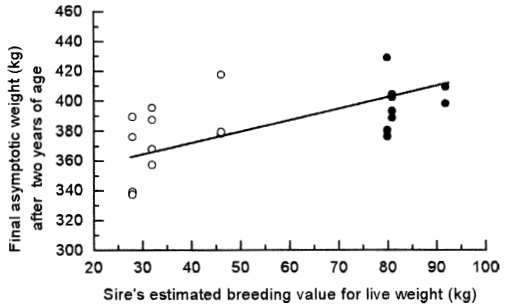
FIGURE 2: Relationship between final asymptotic weight after two years of age and sire's EVB for LW for H (●) and L (❍) heifers. Each dot represents a heifer, and the regression equation is y=355.4 (±10.4) + 0.53 (±0.16)*x; P<0.005; R^2= 0.35.



CONCLUSIONS

The results to-date show that selection for live weight has resulted in slower maturing heifers with larger weights at older ages that tend to show puberty at similar age as the light live weight line heifers. On average, a difference of 100 kg in sire's EBV for LW will result in an increase of 53 kg heifer final asymptotic weight after two years of age.

REFERENCES

Koenen, E.P.C. and Groen, A.F. (1996) *Journal of Dairy Science* **79:** 495-501.

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