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Intake, live weight and feed-conversion efficiency of lactating Holstein-Friesian dairy cows which differ genetically in live weight

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ABSTRACT

The objective of this study was to measure during mid lactation the effect of live weight on the metabolisable energy intake by cows in two lines of Holstein-Friesians selected for heavy or light mature live weight. Yields of milksolids and intakes of dry matter were estimated during two 3-day faeces collection periods. Live weights were measured once in each period. Intakes of pasture dry matter by individual cows were estimated using the alkane technique. Least-square means for live weight, daily yield of milksolids, intakes of dry matter, intakes of metabolisable energy and feed-conversion efficiency for the heavy and the light line were obtained. Linear regression coefficients of metabolisable energy intake on metabolic live weight and yield of milksolids were obtained. Mean values were 15.0 vs. 15.3 kg of dry matter eaten/cow daily, 532 and 488 kg live weight, 1.58 and 1.55 kg milksolids/cow daily, and 108 and 106 g milksolids/kg of dry matter eaten, for the heavy and the light line respectively. The partial regression coefficient of metabolisable energy intake on metabolic live weight was 0.65 MJME/kg $LW^{0.75}$ for both lines, similar to commonly reported values. Both lines had similar feed-conversion efficiencies. These data, from 73 grazing cows, generally support other data, and show that live weight does affect maintenance requirements as expected for cows in the heavy and light live weight lines. But they disagree with previous data because the heavy cows did not have higher intakes.

Keywords: dairy cows; mature live weight; milksolids yield; selection lines; feed-conversion efficiency.

INTRODUCTION

The live weight (LW) of the cow can affect its feed-conversion efficiency, defined as the quantity of milksolids produced per kg of dry matter intake, through the amount of feed required for maintenance (Holmes *et al.*, 1993). Live weight may therefore have a direct effect on overall farm productivity. Previous studies have compared the feed intake and feed-conversion efficiency of heavy and light LW cows from two genetic lines of Holstein-Friesians. Results show that the heavy cows produced more milksolids than the light cows but were not more efficient (Laborde *et al.*, 1998). This was probably because the heavy cows required more energy for maintenance than the light cows (Garcia-Muniz *et al.*, 1998).

The effects of LW on productive performance have been researched (Holmes *et al.*, 1993), however, experimental studies about the consequence of genetic selection for heavy or light LW on the amount of energy required by grazing cows for maintenance and milksolids yield, and using a large number of animals is scarce. The objective of the present grazing experiment was to measure the difference in metabolisable energy intake by the cows in two lines of 73 lactating Holstein-Friesian dairy cows selected for light or heavy mature LW.

MATERIALS AND METHODS

The formation of the two genetic lines of heavy and light LW cows has been described by Garcia-Muniz *et al.* (1998). In the present study, 73 Holstein-Friesian dairy cows, 35 from the heavy and 38 from the light line, were rotationally grazed as a single mob in mid lactation and offered a generous daily pasture allowance of 45 kg DM/cow as assessed by a calibrated rising plate meter (Stockdale, 1984).

Dry matter intake of pasture for individual cows was estimated using the *n*-alkanes technique (Dove & Mayes, 1991). A slow-release alkane capsule (Captec (NZ) LTD, New Zealand) was inserted in every cow's rumen, and faecal and grass samples were collected during two periods (period 1 from 30th of November to the 2nd of December and period 2 from the 7th to the 9th of December of 1999), after a 7-day equilibration period. Alkane concentrations in pasture and faeces samples were analysed at the Animal and Food Sciences Division, Lincoln University, using the analytical procedure described by Mayes *et al*. (1986). Feed intake was estimated from the concentrations of C_{33} (natural odd chain) and C_{32} (dosed even chain) as described by Dove & Mayes (1991). Pasture samples were analysed for *in vitro* digestibility by the Animal and Food Sciences Division, Lincoln University.

Milk yield was measured once in each experimental period, using in-line milk meters. Fat, protein and lactose concentrations in milk were measured by Livestock Improvement Corporation, using a Milkoscan 104 infrared analyser (A/S N. Foss Electric, Denmark). Live weight of the cows was measured once in each period.

Least-square means for LW, daily yield of milksolids, daily dry matter intake, daily metabolisable energy intake and feed-conversion efficiency for the heavy and the light LW line were obtained using a mixed linear model. The model included the fixed effects of LW selection line and the random effects of period, interaction between LW selection line and period, and the residual error. Lactation number and days in milk were included as covariates

Efficiencies of metabolisable energy for maintenance and milk production for each line were derived by analysing the metabolisable energy intake for each cow with the same mixed linear model considering metabolic LW and milksolids yield as covariates. Analyses were carried out using PROC MIXED (SAS, 2000).

RESULTS

Least-square means for LW, dry matter intake, metabolisable energy intake, milksolids yield and feed-conversion efficiency for the heavy and the light lines are presented in Table 1. Cows from the heavy line were indeed heavier than cows from the light line (P<0.001). Differences in milksolids yield, dry matter intake, metabolisable energy intake, and feed-conversion efficiency between lines were not significant, although the feed-conversion efficiency of the heavy line was slightly higher than that of the light line (108 and 106 g milksolids/kg DM, respectively).

The relationships between metabolic LW, milksolids yield and the quantity of metabolisable energy eaten (regression coefficient ± standard error) are shown in the following regression equations:

1 Metabolisable energy intake (MJME/cow/day) for the heavy line = 60.9 (±60.1) + 0.65 (±0.6) metabolic LW + 14.1 (± 14.7) milksolids yield + 0.12 days in milk – 0.16 lactation number.
2 Metabolisable energy intake (MJME/cow/day) for the light line = 44.8 (±60.1) + 0.65 (±0.8) metabolic LW + 29.7 (±25.3) milksolids yield + 0.12 days in milk – 0.16 lactation number.

Linear regression coefficients of metabolisable energy intake on metabolic LW for both lines were 0.65 MJME/kg $LW^{0.75}$/day. Coefficients for milksolids yield were 14.1 and 29.7 MJME/kg milksolids for the heavy and the light line, respectively but neither was significant (Table 1).

DISCUSSION

The difference in average LW between the two lines in the current experiment was smaller than that reported by Laborde *et al.* (1998) for the mature cows of the same two lines and may not have been large enough to show the commonly reported effects on dry matter intake (Holmes *et al.*, 1993). Thus, both lines had similar values for dry matter intake and for feed-conversion efficiencies.

The differences in milksolids yield between the two lines were non-significant. These results are in agreement with a similar experiment reported by Hansen (2000).

The present values for the regression coefficient of metabolisable energy intake on metabolic LW were 0.65 MJME/kg $LW^{0.75}$ for both the heavy and the light line. Even though neither of the LW coefficients were statistically significant, they are in accordance with corresponding estimates for maintenance requirements from calorimetric experiments calculated from indoor conditions (0.6 – 1.0 MJME/kg $LW^{0.75}$; Holmes *et al.*, 1993) and from other outdoor and indoor experiments (0.7 – 1.1 MJME/kg $LW^{0.75}$; Hutton, 1962; Curran & Holmes, 1970).

The theoretical values (Holmes & Wilson, 1987) of metabolisable energy required by the heavy and the light cows for maintenance and production using the present values for LW and milksolids yield were calculated at 169 and 163 MJME/day respectively. These values are similar to the values measured in this study (158 and 161 MJME/day, for both the heavy and the light LW line, respectively. Table 1).

It should be noted that, in theory, the regression coefficients of metabolisable energy intake on milksolids yield should be around 70 MJME/kg milksolids (Holmes & Wilson, 1987). The lower values obtained in the present experiment may be explained by the facts that the other covariates in the equations 1 and 2 accounted for much of the relatively small variation in metabolisable energy intake between the cows, and that the variation between milksolids yield between cows was relatively small.

The metabolisable energy required for maintenance for both the heavy and the light cows calculated in this experiment (0.65 MJME/kg $LW^{0.75}$) is similar to the theoretical expectations for maintenance costs. However, the present values for metabolisable energy intake do not agree with previous work in this programme, which showed larger intakes by cows in the heavy LW line (Laborde *et al.*, 1998; Caicedo-Caldas *et al.*, 2001).

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TABLE 1: Least square mean values (±SEM) for live weight, intakes of dry matter and metabolisable energy, daily yield of milksolids, feed-conversion efficiency and regression coefficients of metabolisable energy intake on metabolic live weight and milksolids yield for genetically heavy (n = 35) or light (n = 38) Holstein-Friesian cows.

	Genetic Line		
	Heavy	**Light**	**Difference**
Live weight (kg)	532±7.2	488±6.9	***
Dry matter intake (kg DM/cow/day)	15.0±0.4	15.3±0.4	NS
Metabolisable energy intake (MJME/cow/day)	158±4.3	161±4.2	NS
Milk solids yield (kg/day)	1.58±0.04	1.55±0.04	NS
Feed-conversion efficiency (g milksolids/kg DM intake)	108±3.2	106±3.1	NS
Regression coefficients of metabolisable energy intake on			
Metabolic live weight (MJME/kg $LW^{0.75}$)	0.65±0.6	0.65±0.8	NS
Milksolids yield (MJME/kg milksolids)	14.1±14.7	29.7±25.3	NS

NS = not significant

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