EFFECTS OF BODY SIZE ON FOOD CONVERSION EFFICIENCY IN DAIRY COWS

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ABSTRACT

The present experiment was designed with the broad objective of examining the importance of differences in body size amongst high producing cows, on their efficiency (FE) of producing milk. For the purpose, a total of 30 multiparous cows (22 Friesians and 8 Jerseys) with similar milkfat (MF) yields were selected from the Dairy Cattle Research Unit at Massey University. Body weight (BW) of the cows ranged between 310 and 565 kg and they were 4-7 years old. Whilst no account of the calving dates was taken, most of the cows were in early to mid lactation. The experiment was divided into two parts- a 25 day grazing period and an 18 day indoor feeding period. During the grazing trial, cows were divided into three "size" groups- large, medium and small, 10 cows in each group (8 Jerseys in the "small" group), but during indoor feeding 11 Friesians and 5 Jerseys were used. The three groups of cows were offered a generous daily herbage allowance and grazed side by side in separate parts of a paddock. The herbage fed during the grazing and indoor feeding periods consisted of a mixture of high quality perennial ryegrass and white clover and representative samples were taken for in vitro digestibility determination. The daily faecal outputs, and then dry matter (DM) intakes, were estimated using gelatin pills and controlled release capsules (CRC) containing chromic oxide (Cr_2O_3). Milk yield and composition, BW and condition score change were measured during both experiments. The effects of body size (BW, wither height and chest depth) and breed (and Friesians and Jerseys combined) on intake, production and FE were studied. Energy in milk (NE milk) was estimated from milk composition and FE was then calculated as milk energy produced divided by total ME consumed. Finally using the General Linear Models procedure of the SAS statistical packet, analysis of variance, correlations, and multiple regression analyses were carried out. Intakes during the outdoor experiment were estimated from faecal outputs. Their accuracy, however, may have been reduced by insufficient sampling over the day in the case of the period during which gelatin capsules were administered, and because of the loss of

capsules from some cows or underestimation of intakes during the CRC feeding period. The difference in the mean BW between large- medium and medium-small size groups was 80 kg in both cases. The medium group (Friesians) ate 3.9% less DM, produced 2.8% less NE milk and were 2.6% more feed efficient than the large group (Friesians); the small group (mainly Jerseys) ate 13.4% less DM, produced 8.7% less NE milk than the medium ones and were 5.1% more efficient. Friesian cows were 114-127 kg heavier than Jerseys and ate 13.5-20.5% more DM, produced 5.7-8.4% more NE milk but were 5-15% less feed efficient than the Jerseys (outdoors and indoors). Cows which were taller or had greater chest depths had higher levels of intake, and only height was related to production (except MF-in combined data). Further details and the statistical significance of these relationships are summarized below.

1) Although all the cows produced relatively similar amounts of daily MF, NE milk was influenced by BW. This relationship was also affected by breed effects in that the larger cows were Friesians and they tended to produce more protein and lactose than the Jerseys.

2) During the outdoor period, DM intake was positively related to $LW^{0.75}$ in Friesians, and in the combined data all measures of size were significantly correlated with DM intake (and the highest correlation was obtained with $LW^{0.75}$). Similar significant relationships between DM intake and $LW^{0.75}$ were apparent in the multiple regression analyses. During indoor feeding, DM intake was again related significantly to $LW^{0.75}$ although the relationship was not apparent amongst the smaller number of Friesians used.

3) DM intake and NE milk production were strongly related during the indoor experiment but not during the outdoor experiment. DM intake was also significantly associated with liveweight gain (LWG) in the outdoor experiment (from the multiple regression analyses) but not in the indoor experiment.

4) FE was significantly higher for Jerseys than Friesians in the indoor experiment and during period 2 of the outdoor experiment. FE was highly correlated (positively) with NE milk within breeds and overall (0.2-0.4% MJ from regression coefficients), especially during the outdoor experiment (0.3-0.4%/MJ). Increasing $LW^{0.75}$ reduced FE significantly (0.2-0.3%/kg $LW^{0.75}$) in both outdoor and indoor experiments.

5) The grazing cows gained weight during the experiment and this significantly reduced the FE of the cows (6.1-7.3%/kg LWG from the regression analyses).

6) The multiple regression relationships between ME intake and $LW^{0.75}$ (maintenance), production and LWG provided partial regression coefficients as follows:

Maintenance : 0.89 (indoors)-1.40 (outdoors) MJME/$kg^{0.75}$

Production : 0.80 (outdoors)-1.76 (indoors) MJME/MJ NE milk

LWG : 33-40 (outdoors) MJME/kg LWG

These values showed variation when alternative analytical procedures were used. Estimated coefficients differed from published data mainly in respect to the higher values for maintenance requirements (ME_m).

The significance of these results are discussed and it was concluded that dairy cows in New Zealand should be chosen on the basis of an index which allows for differences in body weight as well as production.

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LIST OF ABBREVIATIONS

Admin = Administration

BW = Body weight

CP = Crude protein

CRC = Controlled release capsule

Cr_2O_3 = Chromic oxide

Cr = Chromium

d = Day

DE = Digestible energy

DM = Dry matter

DMD = Dry matter digestibility

DMI = Dry matter intake

FCM = Fat corrected milk

FE = Feed efficiency

FM = Fasting metabolism

g = Gram

GE = Gross energy

ha = Hectare

Ht = Height

k = Efficiency of metabolisable energy utilization

k_g = Efficiency of metabolisable energy utilization for LWG

k_l = Efficiency of metabolisable energy utilization for milk production

k_m = Efficiency of metabolisable energy utilization for maintenance

LW = Liveweight

$LW^{0.75}$ = Metabolic body weight

LWC = Liveweight change

LWG = Liveweight gain

MD = Energy density of feed

ME = Metabolisable energy

MEI = Metabolisable energy intake

ME_m = Metabolisable energy for maintenance

MF = Milk fat

MJ = Megajoules

NE = Net energy

NE milk = Energy content of milk (or milk energy)

OMD = Organic matter digestibility

Pr = Protein

Reg = Regression

SNF = Solid not fat

W = Weight