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Comparative performance and energy metabolism of Jerseys and Friesians in early-mid lactation

P. J. L'HUILLIER, C. R. PARR AND A. M. BRYANT

Ruakura Agricultural Centre
Ministry of Agriculture and Fisheries, Hamilton

ABSTRACT

In the first of 2 expriments, the milk production, food conversion efficiency, and grazing uniformity of Friesians and Jerseys were compared during a grazing trial of 21 d duration in mid lactation. Four groups of each breed, consisting of 12 cows per group, were offered pasture allowances of 10, 20, 30 or 40 kg dry matter (DM)/cow/d. In experiment 2, the energy metabolism of 6 Jerseys and 6 Friesians was compared by means of open circuit calorimetry. Energy balances were established for each cow when offered pasture at *ad libitum*, and at 75% National Research Council (NRC) requirements.

In Experiment 1, on average Friesians produced 26% more milk, 6% more milkfat, 13% more protein and 24% more lactose. At the lowest level of feeding (10 kg DM allowance/cow/d) Friesians produced more milk but less milkfat and protein than the Jerseys. Friesians consumed more pasture dry matter (av 13%), lost more live weight and had a lower food conversion efficiency (61 *v* 67 g milkfat/kg DM consumed) than the Jerseys. It was calculated that milkfat per ha, at a common live weight was lower for the Friesians than Jerseys particularly at high rates of stocking. Partitioning of gross energy into digestible energy or metabolisable energy was not significantly affected by breed in Experiment 2, but the efficiency of utilisation of metabolisable energy for milk and tissue (balance energy) was higher for Jerseys than Friesians (0.58 *v* 0.48 respectively).

The results suggest that in mid lactation Friesians produce more milk and milk solids per cow than do Jerseys because of the greater feed intake of Friesians. In contrast, the higher food conversion efficiency, utilisation of metabolisable energy and dry matter consumption per unit live weight of Jerseys allows them to achieve a higher production per hectare than the Friesians. Comparisons between breeds at other stages of lactation is warranted, particularly in light of current discussions about the system of payment for milk.

Keywords Dairy cattle; milk production; milkfat yield; food conversion efficiency; metabolisable energy.

INTRODUCTION

Few experimental comparisons of the performance and efficiency of Friesians and Jerseys have been made in New Zealand. Information on the effect of breed of cow on production characterisitics is based largely on farmer experience and survey data (Bryant and Macmillan, 1985). Current discussions about payment systems highlight the need for such information.

Bryant *et al.* (1985) combined the data from 2 experiments, one which involved Jerseys, the other Friesians, and concluded that Friesians produced more milk (27 - 36%), milkfat (3 - 7%), protein (12 - 19%) and lactose (23 - 25%) than did Jerseys on both a per cow and per ha basis. They also concluded that the differences reflected higher food conversion efficiency in Friesians rather than higher pasture intake. Similarly, Campbell (1977) found that Friesian x Jersey crossbred cattle were superior to purebred Jerseys in production of milk and milk constituents. This paper reports the results of 2 experiments. The first examined the performance and food conversion efficiency of Friesians and Jerseys over a range of feeding levels in mid lactation. The second experiment examined aspects of energy metabolism in Friesians and Jerseys in early-mid lactation using open circuit calorimetry.

MATERIALS AND METHODS

Animals

The cows were from the Friesian and Jersey herds described by Bryant *et al.* (1985). The proportion of Friesian blood, average breeding index and live weight of the Friesians was 92%, 132 and 418 kg respectively. The proportion of Jersey blood, average breeding index and live weight of the Jerseys was 100%, 132 and 342 kg respectively. In both experiments treatment groups were balanced for production characteristics, calving date, age and body condition.

Experiment 1

Four Jersey groups (12 cows/herd) and 4 Friesian groups were offered nominal herbage allowances of 10, 20, 30 or 40 kg dry matter (DM) cow/d during a 21 d period in mid lactation (20 October 1986 to 14

November 1986). Two 0.2 ha paddocks were used daily and were divided into appropriate areas by temporary electric fences. Jersey and Friesian herds at the same allowance were offered adjacent areas within the same paddock. Appropriate areas of pasture of uniform herbage mass prior to grazing (average 3200 kg DM/ha) were offered to the treatment groups following each morning milking. Milk yield was measured at 6 consecutive milkings each week. Composition was determined by infrared analysis on 3 samples bulked from each of 2 milkings. Cow live weight and condition score were determined on 3 consecutive days at the start and end of the experimental period.

Herbage mass, before and after grazing and grazing uniformity was determined on 5 d each week. Herbage mass of each group was determined by cutting to ground level 2 quadrats (0.25 m^2) of herbage with approximately the mean of 30 pasture probe readings. Uniformity of grazing was calculated as the standard deviation of 30 individual recordings of grazing height, measured after grazing by a rising plate meter.

Effects of treatments on production characteristics was assessed by covariate analysis using data from the 14 d preceeding the experimental period as covariates.

Experiment 2

Aspects of energy metabolism of 6 Jersey and 6 Friesian cows were compared by open circuit calorimetry during the 8th to 16th weeks of lactation (1 October 1986 to 17 November 1986). The comparison was made at each of 2 feeding levels (*ad libitum* and 75% National Research Council requirements) in a latin square layout, giving a total of 24 energy balances.

Prior to commmencement of the experiment all cows were trained for excreta collection and calorimetry procedures. All cows spent 23 d on each feeding level. This was made up of a 10 d preliminary feeding period and a 13 d balance and digestibility period.

Fresh herbage was cut twice daily by a modified flail harvester and offered to the cows between 0800 and 1100 h and between 1530 and 1700 h. Cows had access to water at all times. During the experimental period pasture was the sole diet. At all other times cows grazed good pasture as 1 group.

Collection of samples and their analysis were as described by Bryant *et al.* (1977). Analysis of energy balance data was by regression on a within cow basis (Trigg *et al.*, 1980). Regressions calculated for each animal were pooled within breeds and differences between breeds were tested for significance.

RESULTS

Experiment 1

Herbage allowance and mass before grazing were not significantly different between treatments (Table 1). Herbage mass after grazing increased with feeding level. The percentage herbage utilisation was lower for Jerseys than Friesians (mean 46% and 50% respectively) and Friesians grazed pastures lower and more evenly than did Jerseys (3.4 ± 0.75 cm *v* 3.7 ± 1.75 cm respectively). Averaged over feeding levels on a per cow basis, Friesians produced 26% more milk ($P<0.01$), 6% more milkfat ($P<0.05$), 13% more protein ($P<0.05$) and 24% more lactose ($P<0.05$) than did Jerseys (Table 2). At the lowest feeding level, Friesians produced more milk but less milkfat and protein than the Jerseys (Table 2). Friesians had a lower ($P<0.05$) efficiency of food conversion (61.2 *v* 67.0 g milkfat/kg DM consumed respectively). The interaction between breed and allowance was significant ($P<0.05$) for dry matter intake and FCE (Table 2). Production characteristics of the 2 breeds were calculated on a per ha basis, and is shown in Fig. 1. At a common live weight there was no difference in milk yield between breeds, but Friesians produced less milkfat and total solids than Jerseys, particularly at high stocking intensities.

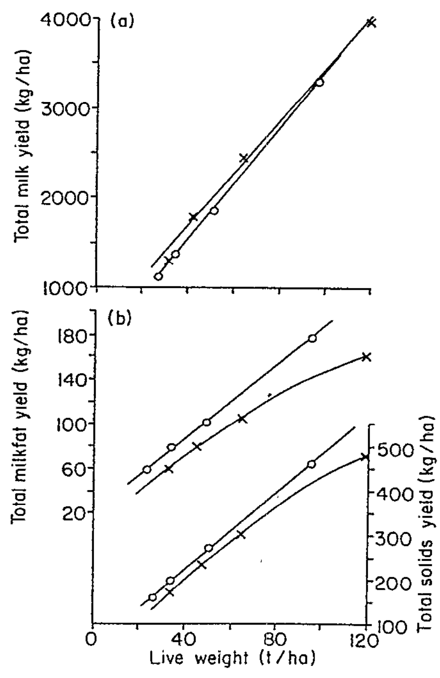

FIG. 1 Total milk yield (Fig. 1a) and milkfat and total solids yield (Fig. 1b) expressed against live weight per ha for Jerseys (O — O) and Friesians (x—x).

TABLE 1 Herbage allowance, herbage mass before and after grazing, and uniformity of grazing.

Parameter	Breed	Feeding level (kg DM allowance/cow/d) 10	20	30	40	SE	Significance[2] Breed
Herbage allowance (kg DM/cow/d)	J	10.7	21.6	31.8	42.6	2.6	NS
	F	11.0	21.9	31.7	43.9		
Herbage mass (t DM/ha)							
Before grazing	J	3.22	3.29	3.18	3.30	0.27	NS
	F	3.30	3.24	3.17	3.19		
After grazing	J	1.27	1.70	1.86	2.13	0.16	NS
	F	1.10	1.54	1.79	2.12		
Grazing height and uniformity[1] (cm)	J	2.2±1.0	3.7±1.4	3.8±1.9	5.1±2.7		
	F	1.6±0.2	3.6±0.4	3.8±1.0	4.9±1.4		

[1] Standard deviation of grazing height.

[2] Interactions not significantly different between breeds for all variables.

TABLE 2 Milk yield and composition, liveweight loss, dry matter (DM) intake and food conversion efficiency (FCE).

Parameter	Breed	Allowance (kg/cow/d) 10	20	30	40	SED	Significance Breed	Breed x allowance
Milk yield (kg/cow/d)	J	10.9	12.3	13.6	14.3	0.44	**	**
	F	13.2	16.2	17.8	17.2			
Milkfat content(%)	J	5.31	5.52	5.40	5.49	0.15	**	NS
	F	4.24	4.47	4.64	4.85			
Protein content(%)	J	3.47	3.83	3.86	3.93	0.08	NS	NS
	F	3.04	3.35	3.41	3.61			
Lactose content(%)	J	5.04	5.00	5.04	5.01	0.06	NS	NS
	F	4.86	4.97	5.04	4.99			
Fat yield (kg/cow/d)	J	0.58	0.68	0.73	0.77	0.02	*	**
	F	0.55	0.72	0.82	0.93			
Protein yield (kg/cow/d)	J	0.38	0.47	0.52	0.55	0.02	*	*
	F	0.40	0.54	0.61	0.62			
Lactose yield (kg/cow/d)	J	0.55	0.61	0.70	0.72	0.03	*	*
	F	0.40	0.54	0.61	0.62			
Liveweight loss (kg/cow)	J	-5.7	-7.3	-6.3	-1.9	2.47	NS	NS
	F	-11.5	-10.7	-8.6	-2.9			
DM intake (kg DM/cow/d)	J	6.52	10.32	12.40	14.19	2.12	NS	*
	F	7.33	11.64	14.88	15.68			
FCE (g milkfat/kg DM)	J	89.0	65.9	58.9	54.3	2.14	*	*
	F	75.0	61.8	55.1	52.9			

[1] Standard error of difference

Experiment 2

The average breeding index, live weight and milk production of the Friesians and Jerseys were similar to those described for Experiment 1. The Friesians also consumed more DM per cow but less per unit live weight than the Jerseys (3.2 *v* 3.7% respectively at the *ad libitum* feeding level).

Within-cow regression analysis showed that the partitioning of energy was not affected by breed except in the case of metabolisable energy (Table 3). Friesians partitioned significantly (P>0.10) more metabolisable energy into heat than did the Jerseys. Efficiency of utilisation of metabolisable energy for milk and tissue (energy balance) was significantly lower for Friesians than Jerseys.

DISCUSSION

The higher per cow production of the Friesians relative to the Jerseys found in the present experiment agree with other New Zealand data (Campbell, 1977, Bryant *et al.*, 1985, Macmillan *et al.*, 1981, New Zealand Dairy Board, 1983). These values are however lower than those reported by Gibson (1986), who found that British Friesians produced 50% more milk, 13% more milkfat and 29% more milk protein than their Jersey contemporaries.

In this study, the higher per cow production of the Friesians was due to higher food intake (13%) compared with the Jerseys. Such findings have been reported for some previous studies (Blake *et al.*, 1986; Gibson, 1986) but not all (Bryant *et al.*, 1985). Bryant *et al.*, (1985) concluded that the higher production of Friesians was due to superior food conversion eficiency (45 *v* 40 g milkfat/kg DM intake for Friesians and Jerseys). Conversely in this study food conversion efficiency was lower for Friesians than Jerseys (61 *v* 67 g milkfat/kg DM consumed). In addition, liveweight loss throughout the trial period was higher for Friesians (8.4 *v* 5.3 kg for Friesians and Jerseys respectively). In this study Friesians and Jerseys were compared during mid lactation only (14th to 17th week of lactation), at other stages of lactation, breed effects on food conversion efficiency may differ. However, Gibson (1986) found that over a whole lactation food conversion efficiency of Jerseys was 7.8% higher than Friesians, similar to the 8.4% observed in this study. Similarly, Campbell (1977) found a 3% advantage in food conversion efficiency toward Jerseys compared with Friesian x Jersey crossbred, grazing as 1 herd.

The greater efficiency of the Jerseys may reflect differences in their energy metabolism. Partitioning of gross energy into digestible and metabolisable energy was similar between breeds. Efficiency of utilisation of metabolisable energy for milk and tissue was however higher for the Jerseys. This was a reflection of a lower heat increment for the Jerseys and agrees with the observation by Brody (1945) that Jerseys have a lower metabolic rate than Holsteins. Jersey cattle have the ability to consume more food per unit live weight than Friesians (Taylor *et al.*, 1986) which may reflect their heavier internal organs (Butler-Hogg and Wood, 1981) and which in turn may be associated with greater efficiency and milk production potential (Jenkins *et al.*, 1986).

At a common live weight, milkfat production per ha was higher for the Jerseys than Friesians, particularly at high rates of stocking. This difference probably reflected both the greater efficiency of food conversion by the Jerseys as well as their ability to consume more DM per unit of live weight (3.2 *v* 2.9% for Jerseys and Friesians respectively). The observation reported here that higher per ha

TABLE 3 Regression analysis of energy partitioning.

X	Y	Slope Friesian	Slope Jersey	Difference (F-J)	SED[1]	Significance
GE[2]	DE[2]	0.726	0.727	-0.001	0.057	NS
DE[2]	Urine energy	0.054	0.047	0.007	0.019	NS
	Methane energy	0.056	0.054	0.002	0.013	NS
ME[2]	Heat energy	0.527	0.420	-0.106	0.058	†
	Balance energy	0.484	0.580	-0.106	0.058	†
	Milk energy	0.223	0.224	-0.001	0.110	NS
	Tissue energy	0.261	0.356	-0.095	0.132	NS

[1] Standard error of differences between slopes.

[2] GE Gross energy; DE Digestible energy; ME Metabolisable energy.

production of milk solids is possible with Jerseys than with Friesians is of uncertain applicability to a whole lactation in a farm situation. That it may apply is suggested by recent evidence (A.M. Bryant and K.J. Paul, unpublished), based on supplier statistics for a large Dairy company. The highest per ha production within a given locality is more commonly achieved by herds producing milk with a fat content greater than 4.8% than by herds producing milk of less than 4.8% milkfat.

This evidence of the superior productive ability of Jerseys contrasts sharply with the conclusions of Bryant *et al.* (1985). The necessity to resolve these breed efficiency issues within the New Zealand industry is highlighted by the current discussions about the system of payment for milk. For example, Gibson (1984) found that Friesians were more efficient at turning *food into money* on a milk yield payment system, but less efficient than Jerseys under a fat plus protein yield less a deduction for volume payment system.

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