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# Effect of level of concentrate supplementation on methane emission of Holstein and Holstein-Jersey dairy cows

T Yan, C P Ferris, C S Mayne
Agri-Food and Biosciences Institute, Hillsborough, Co Down BT26 6DR, United Kingdom
*Email: tianhai.yan@afbini.gov.uk*

**Introduction** Enteric fermentation in ruminants is an important source of methane ($CH_4$) production. In the UK, ruminants contribute approximately 20% of all $CH_4$ emission, with most arising from cattle. This presents a considerable challenge for the dairy industry in the battle against global warming, and reduced $CH_4$ emission is likely to be a major target for government policy within the next few years. The objectives of the present study were to evaluate the effects of level of concentrate supplementation and cross-breeding of Holstein cows with Jersey sires on $CH_4$ production.

**Materials and methods** Eight Holstein and 8 Jersey-Holstein first lactation cows were used in a 4 period (6 weeks/period) changeover study. Each breed was offered *ad libitum* mixed diets of grass silage with 2 levels of concentrates (0.30 vs. 0.70 kg/kg DM), so the dietary concentrate levels for each breed were either 0.30, 0.70, 0.30 and 0.70 kg/kg DM or 0.70, 0.30, 0.70 and 0.30 kg/kg DM during the 4 periods. The animals were on experiment from approximately 28 days of lactation and there was a 10 week break interval between periods 2 and 3. During the pre-experimental period and the break interval, all animals were offered the same silage and concentrates with a ratio of 0.50/0.50 (DM basis). The animals were housed in cubicle accommodation and then transferred to metabolism units for an 11 day period. Faeces and urine outputs were collected from day 3 to 8 in metabolism units. From day 9 to 11, cows were placed in indirect respiration calorimeter chambers with gaseous exchange measured during the final 48 hours. Data were analysed by analysis of variance to examine effects of breed and dietary concentrate level, using experimental period as block.

**Results and discussion** There was no significant interaction between cow breed and concentrate level (Conc. L) on any parameter. On average across the 2 concentrate levels, cow breed had no significant effect on live weight or milk yield, but Jersey-Holstein cows had higher body condition scores ($P < 0.05$), DM intake ($P < 0.01$) and corrected milk yield (milk energy output/energy content per kg standard milk (3.1 MJ/kg), $P < 0.05$) (Table 1). Total $CH_4$ output and $CH_4$/milk yield were higher with Jersey-Holstein cows ($P < 0.01$), while cow breed had no significant effect on $CH_4$/DM intake, $CH_4$-E ($CH_4$ energy)/GE intake or $CH_4$/corrected milk yield. On average across the 2 breeds, cows offered the high concentrate diet had higher DM intake, milk yield and corrected milk yield ($P < 0.001$), but lower $CH_4$/DM intake, $CH_4$/milk yield, $CH_4$/corrected milk yield and $CH_4$-E/GE intake ($P < 0.001$). When relating $CH_4$/corrected milk yield to corrected milk yield and $CH_4$/DM intake to DM intake with a common constant, Holstein cows had a marginally larger coefficient in the former relationship (with corrected milk yield ranging from 13 to 30 kg/d) and a slightly smaller coefficient in the latter relationship (Table 2). These linear relationships indicate that cross breeding had little effect on proportional $CH_4$ production.

**Table 1**. Methane emission of Holstein and Jersey-Holstein dairy cows at 2 levels of concentrate supplementation

| | Holstein | | Jersey-Holstein | | | Significance | |
|---|---|---|---|---|---|---|---|
| Concentrate level (kg/kg DM) | 0.30 | 0.70 | 0.30 | 0.70 | s.e. | Breed | Conc. L |
| DM intake (kg/d) | $14.6^{a}$ | $16.6^{b}$ | $15.2^{a}$ | $17.8^{c}$ | 0.34 | ** | *** |
| Milk yield (kg/d) | $18.2^{ab}$ | $21.7^{c}$ | $17.9^{a}$ | $20.2^{bc}$ | 0.71 | | *** |
| Corrected milk yield (kg/d) | $18.1^{a}$ | $21.8^{bc}$ | $19.9^{ab}$ | $23.4^{c}$ | 0.73 | * | *** |
| $CH_4$ output (l/d) | $462^{a}$ | $466^{ab}$ | $503^{b}$ | $504^{b}$ | 14.2 | ** | |
| $CH_4$/DM intake (l/kg) | $31.8^{b}$ | $28.4^{a}$ | $33.2^{b}$ | $28.3^{a}$ | 0.90 | | *** |
| $CH_4$/milk yield (l/kg) | $25.9^{bc}$ | $22.2^{a}$ | $28.8^{c}$ | $25.5^{b}$ | 1.04 | ** | *** |
| $CH_4$/Corrected MY (l/kg) | $25.9^{b}$ | $22.0^{a}$ | $25.6^{b}$ | $22.1^{a}$ | 0.96 | | *** |
| $CH_4$-E/GE intake (MJ/MJ) | $0.068^{b}$ | $0.061^{a}$ | $0.071^{b}$ | $0.061^{a}$ | 0.0020 | | *** |

**Table 2.** Linear relationships between proportional $CH_4$ emission and corrected milk yield (MY) and DM intake

| | | | |
|---|---|---|---|
| Holstein | $CH_4$/corrected MY = -0.980 [Corrected MY] + 45 | $R^2 = 0.71$ | Eq. [1] |
| Jersey-Holstein | $CH_4$/corrected MY = -1.054 [Corrected MY] + 45 | $R^2 = 0.54$ | Eq. [2] |
| Holstein | $CH_4$/DM intake = -1.088 [DM intake] + 47 | $R^2 = 0.24$ | Eq. [3] |
| Jersey-Holstein | $CH_4$/DM intake = -0.982 [DM intake] + 47 | $R^2 = 0.37$ | Eq. [4] |

**Conclusions** Increasing dietary concentrate level reduced methane emission as a proportion of feed intake and milk yield. However, cow breed (Holstein vs. Jersey-Holstein) had no significant effect on methane output as a proportion of feed intake or energy corrected milk yield.

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