

## Effects of dietary protein concentration on energetic efficiency and methane emission in lactating dairy cows

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**Introduction** A series of studies have been undertaken to examine effects of dietary protein source and concentration on milk production, energy and nitrogen (N) utilisation efficiencies and fertility in dairy cows. The present study evaluated effects of dietary crude protein (CP) concentration on energetic efficiency and methane emission in lactating dairy cows.

**Materials and methods** Forty seven first and 40 multi-lactation Holstein dairy cows were used in a continuous design study (from week 1 to 44 of lactation) to examine effects of dietary CP concentration on animal performance and nutrient utilisation. The CP concentrations evaluated were 180, 150 and 120 g/kg DM in mixed diets containing 450 g/kg DM of forage (60% grass silage and 40% maize silage (DM basis)) and 550 g/kg DM of concentrates. Concentrate supplements (n = 3) consisted of different proportions of the same ingredients (barley, wheat, sugar beet pulp, citrus pulp, soya bean meal, rapeseed meal and molasses). Full details of experimental design, animal, diets and managements are reported by Law *et al* (2008). During early (70 to 90 days), mid (150 to 170 days) and late (230 to 250 days) lactation, the same 4 cows and 4 heifers from each treatment were transferred to metabolism units for 8 days with measurements of feed intake and faeces and urine outputs during the final 6 days. Immediately following completion of digestibility measurements, all cows were transferred to indirect respiration calorimeter chambers for 3 days with gaseous exchange measured during the final 2 days. Live weight was recorded at the beginning and end of these measurements and milk yield and fat, protein and lactose concentrations in milk were measured daily. The data were analysed as a one way ANOVA, with period as block.

**Results** There was no significant difference in live weight or fat, protein or lactose concentration in milk between the 3 diets, but increasing dietary CP concentration significantly increased DM intake (16.5, 18.4, 19.5 kg/d, s.e. 0.43,  $P < 0.001$ ) and milk yield (20.6, 26.1 and 28.3 kg/d, s.e. 0.94,  $P < 0.001$ ). Increasing dietary CP concentration significantly increased GE intake, energy outputs in urine and milk and heat production ( $P < 0.001$ , Table 1). Faecal energy output was lower with low than medium CP diets ( $P < 0.001$ ), but there was no significant difference between medium and high CP diets. Dietary CP concentration had no significant effect on methane energy output, energy balance or energy partitioning between milk and body tissue (milk energy/ME intake and energy balance/ME intake). There was no significant difference in the efficiency of ME use for lactation ( $k_l$ ) between the 3 diets, when using ME requirements for maintenance of Agnew *et al.* (2004). Increasing dietary CP concentration significantly reduced methane emission as a proportion of DM intake ( $P < 0.05$ ) and milk yield ( $P < 0.01$ ), but the differences between medium and high CP diets did not reach significance.

	Dietary CP concentration (g/kg DM)			s.e.	Sig.
	120	150	180		
GE intake (MJ/d)	301.0	340.0	363.1	7.84	***
Faecal energy output (MJ/d)	84.8	94.0	93.5	2.59	*
Urine energy output (MJ/d)	11.8	13.3	14.4	0.28	***
Methane energy output (MJ/d)	20.1	20.3	21.7	0.63	
Heat production (MJ/d)	124.9	132.0	143.2	3.06	***
Milk energy output (MJ/d)	64.1	79.6	86.1	2.44	***
Energy balance (MJ/d)	-4.7	0.7	4.3	3.02	
Milk energy/ME intake (MJ/MJ)	0.354	0.376	0.367	0.0085	
Energy balance/ME intake (MJ/d)	-0.036	0.000	0.017	0.0153	
Efficiency of ME use for lactation ( $k_l$ )	0.551	0.579	0.563	0.0130	
Methane output/DM intake (l/kg)	31.1	28.2	28.2	0.83	*
Methane output/milk yield (l/kg)	25.7	20.9	20.4	1.13	**

**Conclusions** Reducing dietary CP concentration significantly decreased feed intake and milk production, but had no effects on energy partitioning between milk and body tissue or  $k_l$ . Increasing dietary CP concentration from 120 to 150 g/kg DM significantly reduced methane emission as a proportion of DM intake and milk yield, but further increasing dietary CP concentration to 180 g/kg DM had no effect.

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### References

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