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Prediction of methane emission of dairy cows offered fresh grass at maintenance level

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Key words : cattle, chemical composition, fresh grass, grass maturity, methane emission

Introduction Methane (CH₄) production from cattle is a considerable source of greenhouse gases, which is responsible for global warming. Fresh grass is the most important forage for ruminant animals across the world, but there is little information available for prediction of CH₄ output from cattle offered fresh grass. The objective of the present study was to evaluate the relationship between CH₄ emission and nutritive value of fresh grass.

Materials and methods Fresh grass used was harvested daily from the primary growth of perennial ryegrass swards and offered to 2 groups of dry, non-pregnant dairy cows (n=8) at maintenance level of energy intake, with total collection of faeces and urine for 6 weeks (3 weeks/group). The measurement period covered grass growth period from early growth to late maturity. A similar procedure was repeated for the first re-growth grass from the same swards. Details of the experimental design were presented previously (Yan *et al.*, 2008). During each measurement week, cattle were transferred to indirect respiration calorimeter chambers and housed there for 3 days with gaseous exchange measured during the final 2 days. Individual cow data (n=28) were used to develop equations for CH₄ emission.

Results and discussion The minimum, maximum, mean and s.d. values for CH₄ emission were 165, 312, 251 and 40.1 l/d, for CH₄ emission as a proportion of DM intake (DMI) 35.6, 48.1, 41.7 and 3.03 l/kg, for CH₄ energy output (CH₄-E) as a proportion of GE intake (GEI) 0.077, 0.105, 0.090 and 0.0068 MJ/MJ. Methane output was strongly related to DMI (CH₄ = 51.4 DMI - 57, R² = 0.83). A similar relationship was also obtained between CH₄-E and GEI, i.e., CH₄-E = 0.119 GEI - 3.044 (R² = 0.83), with CH₄-E being 0.091 of GEI (R² = 0.79) if the constant was omitted. These equations can be used to determine the ME concentration of fresh grass in combination with digestibility data from feed evaluation laboratories.

The second objective of the present study was to develop prediction equations for CH₄ output from fresh herbage data based on the chemical composition and also to evaluate mitigation strategies to reduce CH₄ output. The CH₄-E/DEI (DE intake) was positively related to concentration of DM, NDF and ADF (Figure 1) (P < 0.001) and water soluble carbohydrates (WSC, P < 0.01), while negatively related to concentration of CP, lipid and ash (P < 0.001) and GE (P < 0.05). The R² values in these linear relationships are 0.43, 0.40, 0.57, 0.23, 0.59, 0.60, 0.68 and 0.22, respectively. Using a stepwise technique, 3 multiple equations ([1] to [3]) have been developed to predict proportional CH₄ from chemical composition with reasonable R² values (0.65 to 0.77). The unit for CH₄ is l/d, for CH₄-E, DEI and GEI MJ/d, for DMI kg/d, for GE MJ/kg DM, for DM kg/kg and for other variables kg/kg DM. These results indicate that CH₄ can be predicted from chemical composition of fresh grass and manipulation of chemical composition of fresh grass is an effective strategy to reduce CH₄ output.

$$\text{CH}_4/\text{DMI} = 14.24 \text{ GE} + 24.90 \text{ WSC} - 107.50 \text{ CP} - 213 \quad R^2 = 0.65 \quad [1]$$

$$\text{CH}_4\text{-E}/\text{GEI} = 0.028 \text{ GE} - 0.312 \text{ CP} - 0.048 \text{ NDF} - 0.359 \quad R^2 = 0.67 \quad [2]$$

$$\text{CH}_4\text{-E}/\text{DEI} = 0.152 \text{ ADF} + 0.052 \text{ GE} + 0.146 \text{ DM} - 1.407 \text{ Lipid} - 0.861 \quad R^2 = 0.77 \quad [3]$$

Conclusions Methane energy output as a proportion of GE intake was 0.091 with fresh grass offered at maintenance feeding level. Manipulation of chemical composition of fresh grass can reduce CH₄ and proportional CH₄ output can be predicted from chemical composition. These models have scientific and practical implications for ruminant feed evaluation.

Reference

Yan, T., Ferris, C. P., Porter, M. G. and Mayne, C. S. 2008. Effects of grass maturity on metabolisable energy concentration of fresh grass. Presented in the present Proceedings.

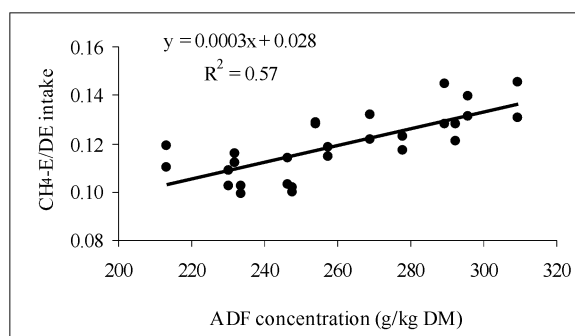


Figure 1 Relationship between CH₄-E/DEI and ADF concentration of fresh grass.