Effect of feeding forages on enteric methane emissions from ruminants: a meta-analysis

Maguy Eugène, Harry Archimède, Sylvie Giger-Reverdin, Michel Doreau, Daniel Sauvant

Effects of Feeding Forages (C3 or C4 metabolism) on Enteric Methane Emissions from Ruminants: a Meta-analysis

M. Eugène[A], *H. Archimède*[B], *M. Doreau*[A], *S. Giger-Reverdin*[C] *and D. Sauvant*[C]

[A] INRA, UMRH 1213, 63122 Saint-Genès Champanelle, France
[B] INRA, URZ, 97170 Petit-Bourg, Guadeloupe, France
[C] INRA, UMRMOSAR 791, 75005 Paris, France

Compared to temperate forages, tropical forages have a lower digestibility and differ in their chemical and structural composition (Leng 1990; Assoumaya *et al* 2007). Ruminants fed tropical forages seemed to have increased methane (CH_4) emissions (Archimède *et al* 2011). The objectives of this study were first to estimate CH_4 emission of ruminants fed forages based on intake level, crude protein (CP) and neutral detergent fibre (NDF) forage content, then to go further in the comparison temperate vs tropical forages (C3 or C4).

A meta-analysis (Sauvant *et al* 2008) was used to compare the effect of different forages (grass and legume, C3 and C4) fed to ruminants on CH_4 emissions. A previous database (Archimède *et al* 2011) was updated by supplementary published data (354 additional treatments) (Web of Science, CAB) that reported, on the same treatment, dry matter intake (DMI), CH_4 emissions, digestibility parameters, forage chemical composition when available. The main factors tested (Proc GLM, Minitab 16) were CP, NDF, acid detergent fibre (ADF) contents of the forage, OM total tract digestibility (OMD), DMI expressed in % of live weight (DMI%LW) as covariates and C3 vs C4 metabolic pathway of forages, Grass vs Legume, temperate vs tropical, animal species (cattle, sheep, goat), and experiment as qualitative factors. Qualitative factors were considered as fixed effects tested on inter-experiment-intra-factor variance. Outlier treatments were removed when their normalized residues >3. The database contained 98 publications, 196 experiments and 466 treatments. The main descriptive parameters of the database are given in Table 1.

Table 1. Number of data (n), mean and standard deviation (sd) of the main parameters, for the different temperate or tropical, grass or legume, C3 or C4 forages of the database.

	C3 Grasses			C4 Grasses			C3 temperate Legumes			C3 tropical Legumes		
	n	mean	sd	n	mean	sd	n	mean	sd	n	mean	sd
CP (g/kg DM)	269	155.2	57.03	27	110.7	61.96	85	204.5	41.80	9	129.2	16.0
NDF(g/kg DM)	216	546.7	102.9	27	679	101.30	75	394.9	108.5	9	562.1	125.8
ADF (g/kg DM)	149	317.8	79.07	27	363.8	52.38	51	309.5	90.33	5	463.8	36.2
DMI/LW (%)	273	1.9	0.64	27	1.8	0.74	85	1.9	0.81	9	2.0	0.65
OMD (%)	149	68.9	9.06	22	61.9	6.17	35	65.8	10.56	4	45.6	3.18
CH_4 g/kg DMI	273	23.3	4.27	27	24.3	5.63	83	19.8	4.77	9	12.2	4.25
CH_4 g/kg DOMI	254	36.5	6.97	26	41.5	10.42	76	32.3	8.39	9	27.7	10.31

CH_4 (g/kg DOMI) = 25.3(±2.2) –3.84(±0.50) DMI%LW + 0.034(±0.004) NDF (g/kgDM) nt = 418 treatments, n = 148 experiments, RMSE =3.73 (g/kg), R^2 adjust. = 83.8%, *P <0.001*.

Methane production, expressed per kg of digestible OMI (g/kg DOMI), was significantly related to DMI%LW and NDF. Our results on DMI%LW were similar to the study of Sauvant *et al* (2011) but we observed that forages NDF was a factor increasing significantly CH_4 emission. No effect of animal species, C3 vs C4 grass was observed on the slopes of the relationship and CH4g/kg DOMI least squares means were not significantly different between C3 grasses, C4 grasses, C3 temperate legumes or C3 tropical legumes, although numerical differences were observed. Results, expressed in g/kg DOMI and DMI/LW(%), differ from those of Archimède *et al* (2011) and also due to inter-experiment-intra-factor variance analyses.

Archimède H., Eugène M., Marie Magdeleine C, Boval M., Martin C., Morgavi D.P., Lecomte P. and Doreau M. (2011). *Anim. Feed Sci. and Technol.* **166-167**, 59.

Assoumaya, C., Sauvant D., Archimède H. (2007). *INRA Prod. Anim.* **20**, 383.

Leng R., (1990). *Nutr. Res. Rev.* **3**, 277.

Sauvant D., Schmidely P., Daudin J.J. and St-Pierre N.R. (2008). *Animal* **2**, 1203.

Email: maguy.eugene@clermont.inra.fr