Enteric Methane Emissions from Ruminants Fed Forages: Role of Tannins Content, a Meta-analysis

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INTRODUCTION & AIMS

Feeding forages, especially those rich in protein (leguminous), could represent an interesting strategy to both provide N to the animal and decrease methane emissions, thus enhancing animal productivity. Forages rich in plant secondary compounds, such as tannins have been studied both for their nutritional effects (positive or negative) on animal productivity (Reed, 1995) and also for their antimethanogenic properties (Doreau et al., 2011; Jayanegara et al., 2012). However, the mitigating effect of tannins on CH4 is inconsistent (Beauchemin et al., 2008; Makkar, 2003). The aims of this study were first to estimate CH4 emission of ruminants fed forages based on intake level, crude protein (CP) and neutral detergent fibre (NDF) forage content, then to go further on and evaluate the effect of tannins content. A meta-analysis approach (Sauvant et al., 2008) was used to compare the effects of different forages, with or without tannins, fed to ruminants on CH4 emissions.

MATERIALS & METHODS

1.1. Data collection: Published data (Web of Science, CAB) that reported, on the same treatment, dry matter intake (DMI), CH4 emissions, digestibility parameters, forage chemical composition when available.
The database contained 103 publications, 204 experiments and 554 treatments. Tannins contents, reported in 21 experiments of the dataset, around 20 different forage species, averaged 4.8 (sd= 22.8) g/kg DM (0– 199).
1.2. Data statistical analysis: A meta-analysis based on Sauvant et al. (2008) was applied (Proc GLM, Minitab 16). The main factors tested on CH4 were: CP, NDF, ADF, digestibility of OM (DOM), feeding level (DMI%LW) as covariates and animal species (cattle, sheep, goat), and experiment as qualitative fixed factors. Tests were performed on inter-experiment-intra-factor variance. Outlier treatments were removed when their normalized residues were >3.

RESULTS

Table 1. Database parameters (n observations, mean, sd, min, max): diets chemical composition, feeding levels (DMI%LW), OM digestibility (DOM) and CH4.

	n	mean	sd	min	max
CP (g/kg DM)	574	156	57	24	394
NDF (g/kg DM)	512	528	129	127	816
ADF (g/kg DM)	349	321	83	110	553
Tannins (g/kg DM)	398	4.8	23	0	199
DMI/LW (%)	590	2.0	0.7	0.5	4.9
DOM (%)	522	67.5	9.2	37.8	91.8
CH4 (g/kg DMI)	586	21.3	5.4	6.7	37.5
CH4 (g/kg DOMI)	518	34.9	8.9	11.0	72.4

❖ **CH4/DOMI = 34.26 - 3.96 FL + 0.027 NDF - 1.72 Log10 (1+TAN) - 0.008 DOM (1)**

(nt = 398 treatments, nexp = 147 experiments, RMSE = 3.1 g/kg, P <0.001)

Where CH4/DOMI is g per kg of digestible OMI, FL is the feeding level (DMI %LW), NDF the dietary NDF content (g/kg DM) and DOM is the digestibility of OM (g/kg DM, *P*<0.12) and TAN is the dietary tannin content (g/kg DM).

- ❖ Similarly to a previous study (Sauvant et al., 2011) we observed that DMI%LW decreased CH_4 emissions. It's the main factor that explain CH4 variations, but moreover, we observed that NDF contents in forages increased significantly CH_4 emissions, whereas tannins contents and to a lesser extent DOM decreased it.
- ❖ Indeed, increased NDF content of forages induced increased fermentation and thus lead to increased CH4 production (Eugène et al., 2014).

Beauchemin et al., 2008. Aust. J. Exp. Agric., 48, 21-27; Doreau et al., 2011. INRA Prod. Anim. 24, 461-474; Eugène et al., 2014. In Proc. ISNH/ISRP, Canberra, Australia. Proc. Aust. Anim. Prod. 2014 Vol 30: 223; Jayanegara et al., 2012. J. Anim. Physiol. Anim. Nutr., 96, 365-375; Makkar, Small Rumin. Res., 49, 241-256. Reed, 1995. J. Anim. Sci., 73, 1516-1528. Sauvant et al., 2008. Animal, 2, 1203-1214. Sauvant et al. 2011. INRA Prod. Anim., 24, 433-446.

CONCLUSION

The **decreasing effect of tannins on CH4 emission** was in agreement with Jayanegara et al. (2012). But in the present study, the **impacts of tannins were lower** presumably because of the **significant decreasing effect of FL** and **increasing effect of NDF effects** and small relationships between factors.