Tithonia diversifolia for Ruminant Nutrition

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Introduction

India and Brazil lead the world ranking of livestock enteric methane emissions (FAO 2006). According to FAO (2006), Brazil (9.6 Tg of CH_4/year) is the highest emitter of methane from cattle, followed by India (8.6 Tg of CH_4/year) and the USA (5.1 Tg of CH_4/year). In livestock, methane (CH_4) formed from enteric fermentation of carbohydrates is primarily responsible for the emissions in the sector. Regarding livestock methane emission, Delgado *et al.* (2012) evaluated 20 tree and shrub species using *in vitro* technique and demonstrated a reducing effect on the amount of methane when *Tithonia diversifolia* was compared with, for example, *Cynodon nlemfuensis* grass. *Tithonia diversifolia* belongs to the division - Sphermatophyta; class - Eudicotiledoneae; sub-class - Metaclamídeas; Order - Campanulate; Family - Asteraceae; Genre - Tithonia, and Species - *Tithonia diversifolia* (Hemsl.), Gray (Souza 2008). *Tithonia diversifolia* can be very useful in animal nutrition (Fig. 1) by increasing the protein content of animal diet at low cost (Murgueitio *et al.* 2010) as well as in the recovery of degraded soils for it grows in areas with low levels of fertility and has high ability to absorb phosphorus, even if it is unavailable to other forage species (Kwabiah *et al.* 2003). The objective of this study was to assess the nutritional qualities, including quantification of enteric methane generated during *in vitro* ruminal fermentation, of *Tithonia diversifolia* as an alternative forage for ruminant nutrition in the tropics.

Figure 1. *T. diversifolia* intercropped with *Cynodon nlenfuensis* (Cipav-Colombia).

Methods

T. diversifolia forage material was evaluated at two developmental stages (booting and pre-flowering) in 5 levels of inclusion with *Brachiaria brizantha* cv Marandu (0, 25, 50, 75 and 100%). The mixtures samples were analyzed for chemical composition (NDF, ADF, hemicelluloses and CP) according to AOAC (1999), *in vitro* fermentation kinetics parameters (Mauricio *et al.* 1999) and VFA and methane production were determined by gas chromatography. Experimental design was randomized and statistical procedure was performed using the Tukey test at 5% probability.

Results

T. diversifolia collected between booting and pre-flowering stages showed similarity in all of the chemical analyzes performed. *B. brizantha* used as control (Table 1) showed 126.6 g/kg DM of CP and 286.3 g/kg DM of hemicelluloses. Comparing both forages, we observed lower NDF and higher CP (166.1 g/kg DM) in *T. diversifolia*. Regarding the *in vitro* fermentation parameters, VFA and methane production, it was found that the treatments with 50% inclusion of *T. diversifolia* had similar degradability to the treatment with 100% Braquiaria (P>0.05), lower gas production rate (P>0.05), lower acetate/propionate ratio (P<0.05), and consequently lower methane emission (Table 1).

Conclusion

The inclusion of 50% of *T. diversifolia* with *Braquiaria brizantha* cv Marandu showed the most promising results as a forage to contribute to the mitigation of enteric methane production. It was probably related to the lower NDF concentration that will end in lower Ac/Pr relationship which promotes lower gas production (CO_2 and CH_4) compared to Braquiaria. However, indigestible NDF (iNDF) and no-fiber carbohydrate (NFC) analysis will better explain the stoichiometry of *T. diversifolia* fermentation.

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Table 1. Content of neutral detergent fibre (NDF, g/kg DM), acid detergent fibre (ADF, g/kg DM), hemicelluloses (HEM, g/kg DM), crude protein (CP, g/kg DM), *in vitro* dry matter digestibility (IVDMD), volatile fatty acids (Acetate / propionate) and methane production (mg/g of DM degraded) of *Tithonia diversifolia* (2 stages = Booting and pre-flowering stages) in different levels of inclusion with *Braquiaria brizantha* cv Marandu. Means followed by different letters in each row (small letters; stages) and columns (capital letters; inclusion levels) differ statistically by the Tukey test at a 5% probability level.

Measurement	Stages	Inclusion levels of:					SED
		100	75	50	25	0	
NDF	Booting Stage	450.1 eA	498.5 dA	546.9 cA	595.4 bA	643.6 aA	17.7
	Pre-flowering	446.5 eA	495.9 dA	545.2 cA	594.5 bA	643.6 aA	
ADF	Booting Stage	386.3 aA	379.2 aA	372.0 aA	364.8 aA	357.9 aA	12.7
	Pre-flowering	383.5 aA	377.0 aA	370.5 aA	364.1 aA	357.9 aA	
HEM	Booting Stage	63.8 eA	119.4 dA	174.9 cA	230.6 bA	286.3 aA	10
	Pre-flowering	63.1 eA	118.8 dA	174.6 cA	230.4 bA	286.3 aA	
CP	Booting Stage	166.1 cA	156.3 bcA	146.5 abcA	136.7 abA	126.6 aA	9.9
	Pre-flowering	117.2 aB	119.7 aB	122.1 aB	124.5 aA	126.6 aA	
IVDMD	Booting Stage	465.2 cA	562.9 bA	578.4 abA	615.9 abA	646.0 aA	27.8
	Pre-flowering	489.0 bA	541.8 bA	585.7 abA	616.1 aA	646.0 aA	
Ac/Pr 6h	Booting Stage	3.1 aA	3.0 aA	2.8 aA	3.1 aA	2.9 aA	0.5
	Pre-flowering	3.6 aA	3.6 aA	2.6 aA	3.4 aA	2.9 aA	
Ac/Pr 12h	Booting Stage	4.6 aA	4.0 abA	2.8 bA	3.3 abA	3.9 abA	0.5
	Pre-flowering	4.2 aA	4.2 abA	2.8 bA	3.3 abA	3.5 abA	
Methane 6h	Booting Stage	6.1 aA	8.1 aA	3.2 aA	5.4 aA	6.9 aA	2
	Pre-flowering	7.0 aA	4.3 aA	5.2 aA	6.4 aA	6.9 aA	
Methane 12h	Booting Stage	5.0 abA	6.4 abA	3.0 bA	8.6 aA	8.2 abA	2
	Pre-flowering	9.8 aA	7.6 aA	6.8 aA	7.6 aA	8.2 aA	

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