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Tithonia diversifolia for ruminant nutrition

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Introduction

According to FAO (2006), Brazil is the highest emitter of methane from cattle, followed by India and the USA (9.6, 8.6 and 5.1 Mt CH_4/yr, respectively). In livestock, CH_4, formed from enteric fermentation of carbohydrates, is primarily responsible for the emissions by the agricultural sector. Regarding livestock methane emission, Delgado et al. (2012) evaluated 20 tree and shrub species using in vitro techniques and demonstrated lower methane production from *Tithonia diversifolia*, a member of the Asteraceae family, than from grasses, for example, *Cynodon nlemfuensis*. *T. diversifolia* can be very useful, not only in animal nutrition, e.g. in silvopastoral arrangements (Plate 1), by increasing the protein content of animal diets at low cost (Murgueitio et al. 2010), but also in the recovery of degraded soils, for it grows in areas with low levels of fertility. Furthermore, it has a high phosphorus uptake ability, even if P is unavailable to other forage species (Kwabiah et al. 2003). The objective of this study was to assess the nutritional quality, including quantification of enteric methane generated during in vitro ruminal fermentation, of *T. diversifolia* as a forage for ruminant nutrition in the tropics.

Methods

T. diversifolia (tithonia) forage was evaluated at 2 developmental stages (booting and pre-flowering) and 5 levels of inclusion with *Brachiaria brizantha* cv. Marandu (brachiaria) (0, 25, 50, 75 and 100% of tithonia in the mixture; DM basis). Brachiaria was cut using the square method (1 m^2) in a paddock managed for milking cows. The forage was sampled when it reached a height of 40 cm, leaving a stubble residue of 20 cm, with fixed cutting intervals of 30 days during the rainy season. Whole tithonia plants were harvested using the square method (1 m^2) as follows: during the booting stage, when plants reached 80 cm (leaves plus stem); and 40 days later at the pre-flowering stage (leaves plus stem and flowers). The harvested forage was milled, dried and mixed according to the

Plate 1. *Tithonia diversifolia* in a silvopastoral arrangement (with *Cynodon nlemfuensis*) and at booting and pre-flowering.

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treatment ratios and later analyzed for: neutral detergent fiber, NDF; acid detergent fiber, ADF; hemicelluloses; and crude protein, CP, according to AOAC (1990); in vitro fermentation kinetics parameters (Mauricio et al. 1999); and volatile fatty acid (VFA) and methane production at 6 and 12 h by gas chromatography. The experimental design was randomized and statistical procedures were performed using the Tukey test at 5% probability.

Results and Discussion

Crude protein was the only chemical parameter for tithonia which was affected by stage of growth, with the value at booting exceeding (P<0.05) that at pre-flowering (166.1 vs. 117.2 g/kg DM) (Table 1). Brachiaria used as a control (0% tithonia) had 126.6 g CP/kg DM and 286.3 g hemicelluloses/kg DM. IVDMD decreased progressively (P<0.05) as the level of tithonia in the mixtures increased. Comparing both forages, we observed lower IVDMD, NDF and hemicelluloses and higher CP at booting (166.1 g/kg DM) in tithonia. Regarding VFA and methane production, overall there were minimal effects of ration composition on these parameters. The absence of differences in methane emissions from pure tithonia and pure brachiaria is at variance with the findings of Delgado et al. (2012), that tithonia produced less methane than grasses. There were indications that acetate/propionate ratio and methane emissions were lowest for the 50:50 mixture of tithonia and brachiaria, but differences were not always significant.

Conclusion

It appears unlikely that including *T. diversifolia* in sowings with *Brachiaria brizantha* cv. Marandu will have any positive effects on animal performance, as digestibility of the mixed rations was lower than for pure grass pasture. Similarly, including *T. diversifolia* had little consistent impact on methane emissions during in vitro digestion studies, so there appears a limited possibility that grazing animals would emit less methane. Regarding the latter, the inclusion of 50% of *T. diversifolia* with *Brachiaria brizantha* cv. Marandu, however, could hold some promise.

Table 1. Concentrations of neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicelluloses (HEM) and crude protein (CP), in vitro dry matter digestibility (IVDMD), volatile fatty acid (acetate/propionate) ratio and methane production (mg/g degraded DM) of mixtures of *Tithonia diversifolia* (2 stages: booting and pre-flowering) and *Brachiaria brizantha* cv. Marandu. Means followed by different letters in rows (lower case; inclusion levels) and columns (upper case; stages) differ statistically by Tukey test at 5% probability.

Parameter	Stage	Inclusion level (%) of *Tithonia diversifolia*					s.e.d.
		100	75	50	25	0 (= brachiaria control)	
NDF (g/kg DM)	Booting	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 (g/kg DM)	Booting	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 (g/kg DM)	Booting	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 (g/kg DM)	Booting	166.1 aA	156.3 abA	146.5 abcA	136.7 bcA	126.6 cA	9.9
	Pre-flowering	117.2 aB	119.7 aB	122.1 aB	124.5 aA	126.6 aA	
IVDMD (%)	Booting	46.5 cA	56.4 bA	57.8 abA	61.6 abA	64.6 aA	2.8
	Pre-flowering	48.9 bA	54.2 bA	58.6 abA	61.6 aA	64.0 aA	
Ac/Pr ratio 6h	Booting	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 ratio 12h	Booting	4.6 aA	4.0 abA	2.8 bA	3.3 abA	3.5 abA	0.5
	Pre-flowering	4.2 aA	4.2 abA	2.8 bA	3.3 abA	3.5 abA	
Methane 6h (mg/g DM degraded)	Booting	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 (mg/g DM degraded)	Booting	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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