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Evaluation of several tropical tree leaves for methane production potential, degradability and rumen fermentation in vitro

K. Pal [a,1], A.K. Patra [a,*], A. Sahoo [b], P.K. Kumawat [b]

[a] Department of Animal Nutrition, Faculty of Veterinary and Animal Sciences, West Bengal University of Animal and Fishery Sciences, 37 K.B. Sarani, Belgachia, Kolkata 700037, India
[b] Central Sheep and Wool Research Institute, Division of Animal Nutrition, Avikanagar 304501, Rajasthan, India

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ABSTRACT

The objective of this study was to investigate 18 tree leaves for methane production potential, degradability and rumen fermentation characteristics in vitro. The higher concentrations ($P<0.01$) of total phenolics were noted in *Prosopis cineraria* (99.7 g kg^{-1}), *Acacia tortilis* (89.4 g kg^{-1}) and *Psidium guajava* (89.3 g kg^{-1}), non-tannin phenolics in *A. tortilis* (36.6 g kg^{-1}) followed by *Syzygium cumini* (26.0 g kg^{-1}), total tannins in *P. cineraria* (82.1 g kg^{-1}) and *P. guajava* (74.3 g kg^{-1}), and condensed tannins in *A. tortilis* (47.2 g kg^{-1}), *P. guajava* (46.6 g kg^{-1}) and *P. cineraria* (43.2 g kg^{-1}). Among the 18 leaves, methane production expressed as ml g^{-1} degradable organic matter (OM) was lower ($P<0.01$) for *Acacia nilotica* (12.6 ml), *P. cineraria* (12.9 ml), *Ficus religiosa* (13.9 ml), *S. cumini* (13.8 ml) and *Azadirachta indica* (13.7 ml) than other tree leaves. Total volatile fatty acid (VFA) concentration was greater ($P<0.01$) for *Tamarindus indica*, followed by *Acacia nilotica* and lowest for *S. cumini*. Degradability of dry matter (DM) was higher ($P<0.01$) for *Moringa oleifera, Acacia senegal*, *Acacia excelsa*, *Morus alba*, *A. indica* and *F. religiosa* (77–83%), and lowest for *Bambusa* sp. (45%) and *Ficus benghalensis* (52%). Microbial biomass production was lowest for *Bambusa* sp. leaves and higher ($P<0.01$) for *S. cumini, A. tortilis, A. nilotica, P. guajava* than other leaves. Overall, the leaves of *S. cumini, A. indica, F. religiosa* and *A. nilotica* not only produced less methane per unit of degradable OM, but also had generally greater OM degradability and favored production of microbial biomass compared with other leaves. These leaves could be explored for decreasing methane production in small ruminant production systems of tropical developing countries.

1. Introduction

Livestock production systems contribute greenhouse gas emissions (GHG) considerably to the atmosphere, and are thus accountable for one of the causes for climate changes and global warming (Gerber et al., 2013). Globally about 96 million tonnes of methane from enteric fermentation and 18 million tonnes of methane from livestock manure are released into the atmosphere (Patra, 2014). Methane emission from enteric fermentation and manure management is one of the major shares of total livestock GHG emission estimated by life cycle assessment analysis, and corresponds to 44% of total anthropogenic methane emissions (Gerber et al., 2013). Besides, methane emission from enteric fermentation represents a significant loss of feed energy.

Several studies have been conducted to screen various feed additives, plant extracts, plant secondary compounds (Patra et al., 2006; Durmic et al., 2014) and tannin-containing legumes and tree leaves (Jayanegara et al., 2011; Bhatta et al., 2012) for inhibition of methane production. Various phytochemicals have been shown to modulate rumen fermentation favorably, and to inhibit methane production in the rumen (Patra and Saxena, 2010, 2011; Seradj et al., 2014). Tree leaves, which contain tannins and saponins in varying amounts, may be incorporated in diets to mitigate enteric methane emissions (Patra and Saxena, 2010). Leaves from trees and browses are important feed resources for small ruminant production in tropical countries especially for landless and marginal farmers (Devendra, 1990). In these regions, feeds from conventional resources are limited and often too expensive for the low input-output livestock production system. The multipurpose tree leaves contain moderate levels of crude protein (CP), minerals and vitamins (Topps, 1992; Patra, 2009) that are deficient in many low-quality roughages. Thus, the multipurpose tree leaves and shrubs have been proclaimed as a solution to feeding of ruminants

* Corresponding author. Fax: +91 33 25571986.
E-mail address: patra_amlan@yahoo.com (A.K. Patra).
[1] Present address: Krishi Vigyan Kendra, West Bengal University of Animal and Fishery Sciences, Ashokenagar, North 24, Parganas 743223, India

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Table 1
Climatic conditions of the regions from where leave samples taken along with season and description of sample collection.

Scientific name	Common name	Climatic environment	Season	Number of trees sampled	Maturity of leaves	Parts of trees taken	Approximate height of the trees (m)
Acacia nilotica	Gum arabic	Arid and semi arid region	Winter (December)	4	Young and mature leaves	Leaves with small branches	10–11
Acacia senegal	Kheri	Arid and semi arid region	Winter (December)	4	Young and mature leaves	Leaves with small branches	8–9
Acacia tortilis	Israeli babool	Arid and semi arid region	Winter (December)	4	Young and mature leaves	Leaves with small branches	6–7
Ailanthus excelsa	Ardu	Arid and semi arid region	Winter (December)	5	Young and mature leaves	Leaves	18–20
Albizia lebbeck	Siras	Arid and semi arid region	Winter (December)	4	Young and mature leaves	Leaves	21–22
Artocarpus heterophyllus	Jackfruit	Tropical wet climate	Winter (January)	4	Young and mature leaves	Leaves	12–16
Azadirachta indica	Neem	Tropical wet climate	Winter (January)	5	Young and mature leaves	Leaves with small branches	17–18
Bambusa sp.	Bamboo	Tropical wet climate	Winter (January)	8	Young and mature leaves	Leaves	22–25
Ficus benghalensis	Banyan	Tropical wet climate, and arid and semi-arid region	Winter (December–January)	4	Young and mature leaves	Leaves	16–20
Ficus religiosa	Peepal	Tropical wet climate	Winter (January)	4	Young and matured leaves	Leaves	22–25
Leucaena leucocephala	Leucaena	Arid and semi arid region	Winter (December)	6	Young and mature leaves	Leaves with small branches	10–12
Mangifera indica	Mango	Tropical wet climate, and arid and semi-arid region	Winter (December–January)	5	Young and mature leaves	Leaves	15–16
Moringa oleifera	Moringa	Tropical wet climate	Winter (January)	6	Young and mature leaves	Leaves with small branches	9–10
Morus alba	Mulberry	Arid and semi arid region	Winter (December)	4	Young and mature leaves	Leaves	3–4
Prosopis cineraria	Khejri	Arid and semi arid region	Winter (December)	5	Young and mature leaves	Leaves with small branches	5–6
Psidium guajava	Guava	Tropical wet climate	Winter (January)	6	Young and mature leaves	Leaves	5–6
Syzygium cumini	Jamun	Tropical wet climate, and arid and semi-arid region	Winter (December–January)	5	Young and mature leaves	Leaves	10–12
Tamarindus indica	Tamarind	Tropical wet climate	Winter (January)	4	Young and mature leaves	Leaves with small branches	20–21