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Animal Feed Science and Technology
119 (2005) 129–142
ANIMAL FEED SCIENCE AND TECHNOLOGY
www.elsevier.com/locate/anifeedsci

Polyphenolics and tannins effect on in vitro digestibility of selected Acacia species leaves

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Received 29 March 2004; received in revised form 12 November 2004; accepted 2 December 2004

Abstract

Browse tree leaves from six species of Acacia being: *A. angustissima*, *A. drepanolobium*, *A. nilotica*, *A. polyacantha*, *A. tortilis* and *A. senegal* were screened to quantify levels of extractable total phenolics (TEP), extractable tannin (TET) and condensed tannin (CT). The CT in the leaf samples were assayed for soluble, protein-bond and fibre-bound CT using a modified butanol/HCl technique through improved extraction of tannin in leaf samples with aqueous sodium deodocyl sulphate (SDS)-β-mercaptoethanol solution. Effect of tannins on in vitro organic matter digestibility (OMD) was assessed by polyethylene glycol (PEG) tannin bioassay. Forages had variable crude protein (CP) ranging from 176 g/kg DM in *A. nilotica* to 229 g/kg DM in *A. angustissima*. *A. nilotica* had the lowest ($P < 0.05$) neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) of 222, 134 and 55 g/kg DM, respectively, compared to *A. polyacantha* (505, 393 and 196 g/kg DM, respectively). The TEP varied among species from 99 in *A. drepanolobium* to 281 mg/g DM in

Abbreviations: ADF, acid detergent fibre; ADL, acid detergent lignin; ANFs, anti-nutritional factors; ANOVA, analysis of variance; CP, crude protein; CT, condensed tannin; DM, dry matter; GP, gas production; ME, metabolisable energy; MW, molecular weight; NDF, neutral detergent fibre; OM, organic matter; OMD, organic matter digestibility; PEG, polyethylene glycol; SDS, sodium deodosyl sulphate; TEP, total extractable phenolics; TET, total extractable tannins

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0377-8401/$ – see front matter
doi:10.1016/j.anifeedsci.2004.12.004

A. nilotica. TET also varied from 84 (*A. drepanolobium*) to 256 mg/g DM in *A. nilotica*. Total CT varied between Acacia spp., and ranged from 52.8 in *A. nilotica* to 98.3 mg/g DM in *A. polyacantha*. Most of CT in Acacia spp. was bound to protein (22.2–50.5 mg/g DM). Soluble and fibre-bound CT fractions varied ($P < 0.05$) among the species from 14.5 to 22.9 mg/g DM and 13.0 to 28.6 mg/g DM, respectively. Addition of PEG in vitro increased gas production, OMD and metabolisable energy (ME) content with the highest response ($P < 0.05$) in *A. angustissima* compared to other Acacia spp. High levels of phenolics and tannins in Acacia spp. samples could limit utilisation of Acacias by ruminants through impaired feed digestibility and nutrient utilisation.

Keywords: Acacia; Browse; Phenolics and tannins; Bound tannins; Gas production; In vitro digestibility; Polyethylene glycol; Tannin bioassay

1. Introduction

Ruminant production in the tropics is limited due to inadequate nitrogen (N) from low quality forages such as hays, straw and stovers (Leng, 1990), which often contain as low as 20–50 g/kg crude protein (CP) in the dry matter (DM) and so do not meet the minimum CP requirement of 80 g/kg DM for optimal rumen microbial function (Annison and Bryden, 1998). Browse tree legumes and shrub foliages (i.e., leaves, twigs, pods and fruits and barks) with their high CP contents of 100–250 g/kg DM (Le Houérou, 1980) have potential as CP supplements in ruminant diets. However, their utilisation could be limited by their high content of polyphenolic compounds (e.g., phenolics and tannins), especially when fed at high levels, due to their adverse effects on feed digestibility and nutrient availability. Tannins are high molecular weight (i.e., >3000 Da) phenolic compounds that bind to proteins to form complexes which precipitate dietary feed nutrients such as carbohydrates, proteins, minerals (Mangan, 1988). Deleterious effects of phenolics and tannins include inhibition of digestive enzymes, toxic effects on rumen microbes (Brooker et al., 1994; Osuji and Odenyo, 1997) and toxic effects on intestinal mucosa (Mangan, 1988).

Browse foliage from Acacia spp. are important components in the diets of cattle, sheep, goats and wild ungulates in arid and semi-arid regions of tropical Africa, including Tanzania. Common Acacia species native to the semi-arid areas of Tanzania include *A. drepanolobium*, *A. hockii*, *A. nilotica*, *A. polyacantha*, *A. tortilis*, *A. senegal* and *A. seyal*. Screening of browse fodder for phenolic and tannin contents is limited by inconsistent analytical techniques used for quantification of tannins (Schofield et al., 2001). Use of internal (i.e., authentic) purified standards from similar forages under study has been suggested (Waterman and Mole, 1994), rather than the use of commercial standards, due to the variability that exists between the nature of the phenolic molecules in the standard versus those in plants (Makkar and Becker, 1993).

Little is known about the chemistry, tannin activity and tannin structure–biological activity relationship in different species of Acacia, and other tropical browse foliages. There is a lack of knowledge on the nutritive potential of browse legume fodder from the different species for example, the *A. angustissima* toxicity that has been reported on rumen microbes (Osuji and Odenyo, 1997) and in sheep (Odenyo et al., 1997), and there is little information