

## Anti-Nutritional Factors in Tropical Legumes

When more nutritious animal feed is in short supply, often the only available source of green fodder for resource-poor smallholder farmers is tree fodder. This may contain anti-nutritional factors such as tannins which adversely affect the animals' health and/or productivity. A better understanding of the effect of tannins on the nutritive value of tree fodders should reduce the risks of using such feedstuffs.

### Background

Most research on leguminous shrubs and trees from tropical and sub-tropical regions has been confined to a few genera which grow naturally in soils of moderate fertility and acidity. However, there is increasing need to identify a wide range of legume shrubs and trees that are adapted to acid-infertile soils in tropical countries. Initial work at Centro Internacional de Agricultura Tropical (CIAT) in Colombia and the Indian Grass and Forage Research Institute (IGFRI) has identified species that are adapted to these types of soils, but most have low nutritive value due to the presence of anti-nutritional factors such as hydrolysable and/or condensed tannins.

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Project completed in 1998



Tree fodder is widely used for livestock feeding in developing countries but its variability makes prediction of nutritive value difficult.

Feedstuffs containing tannins are widely used in developing countries, particularly during dry seasons when more nutritious feeds are in short supply. Due to the nature of tannins, the implications for livestock health and productivity are diverse, ranging from the possibility of direct toxicity to the impairment of nitrogen digestibility. However, little is understood of how tannins exert these adverse effects in the animal and, therefore, progress in developing approaches to counteract the effects has been limited. This project examined tannin chemistry in more detail to elucidate some of the modes of action of this diverse group of substances on the digestibility of plant components.

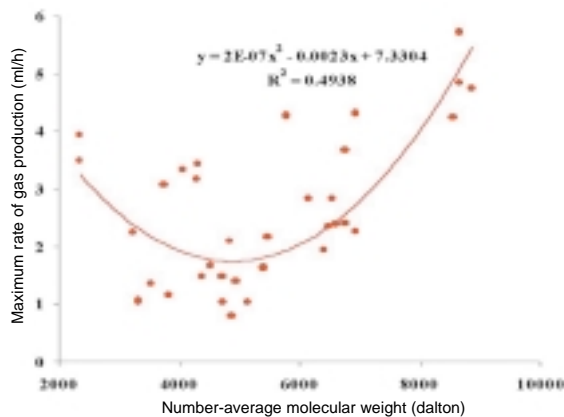
### Research highlights

Initial studies focused on anti-nutritional factors – predominantly condensed tannins – in a range of tropical forages. These were quantified and extracted, and some of their chemical characteristics were investigated using an *in vitro* (laboratory-based) system.

Condensed tannins are not a uniform chemical entity. There was great variation both in the molecular weight

and the monomeric composition of condensed tannins extracted from the six tanniferous tropical legumes studied. This variability appeared to be reflected in corresponding variation in the anti-nutritional activity of tannins from different sources. Of the condensed tannins studied, those from *Leucaena leucocephala* were consistently found to have lower anti-nutritional impact. By comparison, condensed tannins from the closely related *L. pallida* were amongst those with the most deleterious impact on tissue digestibility and enzyme activity. In general terms, the negative impact of condensed tannins upon forage degradability was maximised when their number-average molecular weight was around 4900 dalton (see graph overleaf).

Condensed tannins influenced the digestion kinetics of plant cell walls to a much greater extent after being bound to the cell walls than when solubilised in the culture medium. This observation has considerable significance as a basis for a more detailed understanding of the ways in which tannins exert their anti-nutritional effects.



The anti-nutritional effects of tannins in accessions of *Desmodium ovalifolium* (a tropical creeping legume) appear to be highly dependent on the molecular weight of their constituent tannins.

The impact of tannins on gas production kinetics in an *in vitro* system was also investigated. Condensed tannins in tropical forage legumes have a far greater effect on the **rate** than on the overall **extent** of forage degradation. Furthermore, in the majority of the cases, their impact upon the rate of forage degradation reaches its maximum during the early stages of fermentation (usually within the first 20 hours post-inoculation).

### Uptake

Integrating the findings of this project has generated an approach for characterising 'good' and 'bad' tannins according to their chemistry. This is likely to be of considerable practical use, as one of the problems in assessing the likely impacts of tannins in feeding systems has been the difficulty in interpreting any chemical data that are available.

### Linkages

The project operated through institutional linkages between the UK (IGER), Colombia (CIAT) and India (IGFRI), in parallel with a DFID bilateral-funded project focusing on the development of forage resources for the Indian subcontinent. Specific activities relating to institutional strengthening included the transfer of the gas production technique for feed evaluation to both CIAT and IGFRI. The outputs of this Livestock Production Programme (LPP) are relevant to other LPP projects: R5180: Estimating the nutritive value of tropical forages, R5189, R5483, R6954, R7351 and R7424.

### Relevance to sustainable livelihoods

For resource-poor farmers, the maintenance of livelihoods is most difficult when animal feeds are in short supply, particularly in the dry seasons. During these periods, tree fodder is

often the only feed of relatively high quality that is available. A better understanding of sources of variation in the nutritive value of tree fodder should reduce the risks associated with feeding in times of shortage.

### Selected project publications

- Barahona, R., Narvaez, N., Lascano, C., Theodorou, M.K., Morris, P. and Owen, E. (1998) *In vitro* digestibility of tropical legumes: tannin content and relationship between determinations made using Tilley and Terry and pressure transducer gas techniques. p. 52. In: *In vitro Techniques for Measuring Nutrient Supply to Ruminants. Proceedings of International Symposium of the British Society of Animal Science, University of Reading, 8–10 July 1997*. BSAS Occasional Publication no. 22.
- Deaville, E.R., Owen, E., Adesogan, A.T., Rymer, C., Huntingdon, J.A. and Lawrence, T.L.J. (Eds.). *British Society of Animal Science*, Edinburgh, UK.
- Theodorou, M.K., Barahona, R., Kingston-Smith, A., Sanchez, S., Lascano, C., Owen, E. and Morris, P. (2000) New perspectives on the degradation of plant biomass in the rumen in the absence and presence of condensed tannins. pp. 44–51. In: *Tannins in Livestock and Human Nutrition: Proceedings of an International Workshop, Adelaide, Australia, 31 May–2 June 1999*. ACIAR Proceedings no. 92. Booker, J.D. (Ed.). Australian Centre for International Agricultural Research, Canberra, Australia.

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