Forage quality characteristics of *Lotus tenuis*, narrow-leaf birdsfoot trefoil

Adam D Langworthy [A], Peter A Lane [AB], David Parsons [AB] and Eric Hall [B]

[A] School of Agricultural Science, University of Tasmania, Private Bag 54, Hobart, TAS 7001, Australia, www.utas.edu.au
[B] Tasmanian Institute of Agriculture, University of Tasmania, PO Box 46, Kings Meadows, TAS 7249, Australia, www.tia.tas.edu.au

Contact email: Adam.Langworthy@utas.edu.au

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Introduction

Narrow-leaf birdsfoot trefoil (*Lotus tenuis* Waldst. & Kit.) is a herbaceous perennial legume of Mediterranean origin, which can grow in saline and waterlogged environments (Teakle *et al.* 2010). If this species is to be cultivated in regions constrained by these abiotic factors, it is also vital that herbage produced has a forage quality acceptable for ruminant production. In addition, proanthocyanidin (PA) content is important, and legume species can cause animal production issues if PA content is low, (<0.02%), *e.g.* frothy bloat, or high (>5 %), *e.g.* decreased palatability and digestibility (Larkin *et al.* 1999). This study examined the PA content and forage quality of a range of *L. tenuis* accessions being evaluated for improved seed production and suitability for introduction into grazing systems where salinity and waterlogging are a common problem.

Methods

Plant material and growth conditions

Thirteen accessions of *L. tenuis* and one cultivar each of *L. corniculatus* (cv. Franco) and *L. pedunculatus* (cv. Grasslands Maku) were grown at a field site in northern Tasmania, Australia (147ºE, 41ºS; annual rainfall 670 mm). The site was arranged on weed matting, with genotypes distributed in a randomised design. Site establishment occurred in spring 2011, when greenhouse grown inoculated plants (SU 343) were transplanted into the field. Irrigation was applied when required, until all plants were physiologically mature. At establishment the soil had a pH (water) of 5.4, an electrical conductivity of 0.24 dS/m, and Colwell P and K (mg/kg) of 79 and 213 respectively. Soil fertility was maintained with an annual application of 200 kg/ha of an NPK (0-6-17) fertiliser.

Sample collection and analysis

Twenty plants of each genotype were randomly selected for harvesting in mid autumn 2012, with 20 stems of the current season's growth removed from each plant (cut 25 mm above the crown). All herbage collected from a genotype was bulked and immediately frozen at -20ºC. A modified butanol-HCl method developed by Porter *et al.* (1986) was used to determine the PA content of a sub-sample of whole stems. Herbage for determination of forage quality was separated into leaf and stem fractions and dried at 65°C for 24 h prior to analysis. Total nitrogen (N) was measured using a Flash Element Analyser, and crude protein (CP) concentration was calculated by multiplying the total N values by 6·25. Neutral detergent fibre (NDF) and acid detergent lignin (ADL) content were determined using the ANKOM fibre analyser with filter bags (Van Soest *et al.* 1991). Ash content was obtained by heating samples in a blast furnace for 6 h at 650ºC.

Results and Discussion

Proanthocyanidin content

Minimal genotypic variation occurred in the PA content of the *L. tenuis* population, with the total PA concentration of 12 accessions <0.1%, insufficient to have any positive effect on ruminants (Larkin *et al.* 1999). One accession however had a PA concentration of 0.2%, potentially sufficient to reduce the incidence of frothy bloat without detrimentally affecting voluntary feed intake (Larkin *et al.* 1999). This accession may be useful for future selection stages in developing a commercial cultivar. The mean PA concentrations were 1.3% for *L. corniculatus*, 3.1% for *L. pedunculatus* and 0.1% for *L. tenuis*. These values are lower than those reported by Sivakumaran *et al.* (2006), where PA concentrations were 3.0, 7.2 and 0.8% respectively; however the relative ranking of the species was the same.

Forage quality

Concentrations of CP in the leaf and stem fractions of *L. tenuis* were comparable to those reported by Collins (1988) for *Medicago sativa* plants at early bloom (21.8 - 23.9 and 9.6 - 13.4%, respectively) (Table 1). The leaf and stem fractions of *L. tenuis* also contained similar concentrations of NDF and ADL (Table 1), to those reported for *M. sativa*. The mean ash content of *L. tenuis* was similar in the stem and lower in the leaf fraction than *M. sativa* (6 and 11%, respectively) (Halgerson *et al.* 2004; Table 1). These similarities with *M. sativa* indicate that *L. tenuis* is of suitable quality for use in ruminant production systems. Forage quality parameters of *L. tenuis* were also in the range reported for *L. corniculatus* and *L. pedunculatus* (Table 1). Both of these species have been used successfully as forages, suggesting that the forage quality of *L. tenuis* is also suitable for ruminant production (Ayres *et al.* 2006).

Table 1. Forage quality of field grown *L. corniculatus*, *L. pedunculatus* and *L. tenuis* plants. Values for *L. tenuis* are means with ± 1 standard error and all values are expressed on a % dry weight (DW) basis.

	CP		NDF		ADL		Ash	
	% DW		% DW		% DW		% DW	
Species	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem
Lotus corniculatus	16.8	9.7	20.5	49.2	3.4	9.6	6.3	4.5
Lotus pedunculatus	22.5	9.0	33.5	53.4	8.0	11.2	8.6	8.4
Lotus tenuis	20.4 ± 0.6	9.3 ± 0.4	14.9 ± 0.3	48.4 ± 1.1	3.7 ± 0.2	10.2 ± 0.3	6.8 ± 0.2	5.3 ± 0.2

Conclusion

Identification of an accession of *L. tenuis* with a PA concentration suitable for prevention of frothy bloat has implications for future selection stages involved in developing a new cultivar. This is significant because of the limited ability of protein rich feed to be produced in areas constrained by environmental stresses (Teakle *et al*. 2010). The high CP concentration of *L. tenuis* herbage has the potential to increase the incidence of frothy bloat in these regions if low PA content genotypes are introduced (Larkin *et al*. 1999). Development of *L. tenuis* cultivars with PA levels sufficient to reduce the incidence of frothy bloat is vital, due to the limited experience of producers in frothy bloat management and the high cost of preventatives (Larkin *et al*. 1999).

This study also confirmed the potential of *L. tenuis* to produce herbage of quality similar to *M. sativa* and other *Lotus* species based on measures of CP, NDF, ADL and ash. In conclusion, while further research is needed, it is evident that *L. tenuis* has significant potential to improve the sustainability of pasture and ruminant production in regions constrained by salinity and waterlogging.

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