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The value of *Acacia saligna* as a source of feed for sheep

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SUMMARY

Two pen trials were undertaken to evaluate the usefulness of ***Acacia saligna*** as a source of feed for sheep. In Trial 1, ***A. saligna*** was inadequate as the sole source of nutrients for sheep, weight loss being visually evident. Further, the level of detannification achieved in Trial 1, with the addition of polyethylene glycol (PEG), failed to improve the diet sufficiently.

Trial 2 investigated ***A. saligna*** as the basal source of nutrients together with straw, with or without a supplement of nitrogen in the form of urea or PEG. Sheep supplemented with PEG consumed more ***A. saligna*** than either the control group or those supplemented with urea ($P<0.05$). All sheep readily consumed the ***A. saligna*** in preference to straw. The consumption of straw did not differ ($P>0.05$) among treatment groups, all animals consuming less than 25% of the straw offered. Both the dry matter digestibility and organic matter digestibility were higher ($P<0.05$) where PEG was included in the diet compared to the other two treatments. For all treatments, the animals maintained body weight.

INTRODUCTION

As part of the battle against land degradation and desertification there is an urgent need to develop sustainable grazing systems. ***Acacia saligna***, a native of Western Australia, has been widely acknowledged as a useful species for land conservation. More recently, there has been a focus on the species as a potential source of fodder for ruminants (Degen ***et al***. 1998; Degen ***et al***. 1997; Abou El Nasr ***et al***. 1996; Degen ***et al***. 1995). A common conclusion of researchers is that the presence of condensed tannins is the primary factor inhibiting its use as a feed source (Chriyaa ***et al***. 1997; Degen ***et al***. 1995, 1997, 1998; Abou El Nasr ***et al.*** 1996).

Condensed tannins (CT) can be categorised as soluble, protein bound or fibre bound (Terrill ***et al***. 1992). Tannins bound to proteins or fibre in the leaves may render these indigestible, while soluble tannins can form complexes with dietary proteins following mastication (Vaithiyanathan and Kumar 1993) as well as endogenous proteins including enzymes (Kumar and D'Mello 1995).

The ability of tannins to form strong complexes with proteins is the most important aspect of their anti-nutritional effects. Tannins bind with at least four groups of proteins in the ruminant: dietary proteins, salivary proteins, endogenous enzymes and gut microbes including microbial enzymes (Hagerman and Butler 1981). The effects of CT, such as inhibition of feed intake and digestion by ruminants, are usually ascribed to their ability to bind proteins (D'Mello 1992). The strength of the tannin-protein complexes depends on characteristics of both the tannin and protein (Haslam 1989).

Most research on ***A. saligna*** tends to involve plant material grown in arid and semi-arid regions. However, it is also known to grow prolifically in areas of higher rainfall, e.g. south-west Western Australia where annual rainfall can exceed 1000 mm, as well as in climates ranging from cool to tropical. If the limitations to ***A. saligna*** being a worthwhile source of fodder for ruminants could be overcome then it could serve a dual role of conservation and animal feed.

TRIAL 1

Aims:

The aims of Trial 1 were to:

1. evaluate the usefulness of ***A. saligna*** as a sole source of nutrients for sheep

2. evaluate the effect that partial detannification of ***A. saligna*** might have on its value as a source of nutrients for sheep.

Materials and methods

A feeding trial was conducted during April-June 1999 and involved four Merino wether sheep, each fitted with a permanent rumen cannulae. The experiment was based on a cross-over design, each sheep undergoing each dietary treatment.

Acacia saligna was lopped from a three-year-old plantation at Gidgegannup, Western Australia (sown in 1996 directly from seed). Only foliage less than 12 months old was used. After harvest, material was stored at –18°C

pending feeding. The two feeding regimes used were: (1) control: basal diet of ad libitum access to ***A. saligna***; and (2) basal diet plus 25 g/d polyethylene glycol (PEG). PEG is a detannification agent, tannins binding to PEG in preference to protein (Pritchard ***et al***. 1988; Jones and Mangan 1977). For this trial PEG was first dissolved in water (1:1 w/v) and then administered as an oral dose immediately prior to feeding.

During the trial, animals were fed every morning, followed by collection of faeces and urine. Dry matter intake (DMI) was determined by subtracting the dry matter (DM) weight of daily feed refusal from the amount of feed offered (DM weight). The weight of faeces excreted from each animal was measured and a subsample of each animal's daily faecal output taken (and later pooled) for determination of organic matter content. Dry matter digestibility (DMD) and organic matter digestibility (OMD) were determined on the basis of the amount of DM or OM ingested and the amounts voided.

Results

The intake and digestibility of ***A. saligna*** offered to sheep with or without a supplement of PEG 4000 are shown in Table 1. The DMI of ***A. saligna*** was greater ($P<0.05$) in sheep supplemented with PEG compared to the control diet. This was associated with improved ($P<0.01$) DMD and OMD. The animals were not weighed throughout the trial, but a loss in body condition was obvious in all animals, particularly the control group.

TABLE 1
Intake and digestibility of *A. saligna* offered to sheep with or without a supplement of PEG 4000.

	TREATMENT		SIGNIFICANCE
	CONTROL	PEG 4000	
DMI (g/d)	187[a](57)	499[b](101)	*
DMD (%)	31.3[a](7.9)	36.8[b](9.1)	**
OMD (%)	30.4[a](7.8)	32.1[b](9.1)	**

**P <0.05, **P < 0.01. Values within rows with different superscripts are significantly different. Values within brackets indicate standard deviations.*

Protozoa were present in abundance in ruminal fluid only until the animals had undergone the control treatment, after which there were virtually none present.

Discussion

The DMI of ***A. saligna*** by the sheep that were not supplemented with PEG were lower than those reported by Abou El Nasr ***et al.*** (1996). Where fresh ***A. saligna*** was the sole feed, the DMI of ***A. saligna*** exceeded 800 g/d. Their higher DMI corresponded to a higher DMD of 54.2% compared to 31.1% in the current trial. Neither CT concentration nor its activity was reported for the former trial but such factors are expected to largely explain the differences in DMI between that trial and the present one.

In the trials of Degen ***et al.*** (1995) and Degen ***et al.*** (1997) the DMI of air-dried foliage from mature ***A. saligna*** trees was approximately 200-250 g/d. Both the DMD and OMD in these trials were 31-35%. These figures are comparable to those in the current trial but the experimental animals in the current trial were likely to be significantly heavier than the animals used by Degen ***et al***. However, in Degen ***et al.*** (1997), where foliage was harvested from young trees (8 months old), DMI was less than 150 g/d, despite both DMD (38.3%) and OMD (39.8%) being higher than those harvested from mature trees (32.3% and 33.8% for DMD and OMD, respectively). This was attributed mainly to the much higher CT content of the foliage from the younger trees compared to those obtained from the mature trees, the age of the tree being just one of many factors that may affect its CT content.

The results of this trial indicate that, in this instance, ***A. saligna*** could not be used as a sole diet to maintain the weight of sheep even with partial detannification as a result of inclusion of PEG. A higher dose of PEG or an alternative form of rumen degradable nitrogen might have yielded more positive responses.

TRIAL 2

It was shown in Trial 1 that ***A. saligna*** was inadequate as the sole source of nutrients for sheep. It was also shown that the level of detannification achieved in Trial 1, with the addition of PEG 4000, failed to improve the diet sufficiently to have any real impact on animal performance. of green feed to grazing animals.

Trial 2 was designed to investigate the use of ***A. saligna*** as a basal source of nutrients, with or without a supplement of rumen degradable nitrogen (urea) or PEG (at a dose rate higher than that used in Trial 1). Wheat straw was included in the basal diet to simulate a paddock situation in which plantations of ***A. saligna*** are interspersed with dry pasture during the summer/autumn period in W.A.

Materials and methods

The feeding trial was conducted during April-June 2000. The ***A. saligna*** was sourced from Bakers Hill, W.A. Branches were cut from mature trees (5-6 years old, grown from bare-rooted seedlings) and then manually fed through a mechanical leaf stripper. The ***A. saligna*** offered to the sheep consisted of phyllodes (mostly whole) and small twigs. After harvesting, material was stored at -18°C pending feeding.

The feeding trial was based on a Latin square design. Each of the six Merino wethers were randomly allocated to one of three dietary treatments. The three treatments used were:

1. control: ad libitum ***A. saligna*** + 400 g / d wheat straw (95% DM) (basal diet);
2. basal diet + 50 g / d PEG 4000
3. basal diet + 1% (DM basis) urea sprayed onto the straw and ***A. saligna*** 30 minutes prior to feeding.

Measurements and sampling were the same as those described for Trial 1.

Results

The intake and digestibility of ***A. saligna*** and straw offered to sheep with or without a supplement of 1% urea or PEG is shown in Table 2. Sheep supplemented with PEG consumed more ***A. saligna*** than either the control group or those supplemented with urea ($P<0.05$). All sheep readily consumed the ***A. saligna*** in preference to straw. The consumption of straw did not differ ($P>0.05$) amongst treatment groups, with all animals consuming less than 25% of the straw offered. Both the DMD and OMD were higher ($P<0.05$) where PEG was included in the diet compared to the other two treatments.

No defaunation was evident, suggesting a much lower concentration of CT and / or lower protein precipitation capacity of the CT present in the ***A. saligna*** foliage, compared to the foliage used in Trial 1. For all treatments, the animals maintained body weight.

Discussion

The results of Trial 2 are in stark contrast with Trial 1. The average daily DMI of ***A. saligna*** in the control group was almost seven times the intake of the control animals from Trial 1, and with PEG supplementation DMI was greater than 2.5 times higher in Trial 2 than it was in Trial 1. The DMD and OMD were also considerably higher in Trial 2 compared to Trial 1 and would help explain the higher DMI for Trial 2. Whereas Trial 1 demonstrated clearly that ***A. saligna*** was inadequate as a source of nutrients for sheep, Trial 2 indicated that ***A. saligna*** could in fact play a useful role as a major component of a sheep's diet.

Variations in the CT concentration of the ***A. saligna*** used in the respective trials may explain the differences observed in DMI, DMD and OMD. (Analyses of CT in the ***A. saligna*** of the respective trials has not yet been completed). There are several factors that may influence the CT contained within the foliage of browse species including genotype (Baldwin ***et al***. 1987), season (Hagerman 1988), soil (Barry and Duncan 1984; Kelman and Tanner 1990) and age of the tree (Degen ***et al.*** 1997; Makkar ***et al.*** 1991). The foliage used in the two trials was harvested from different sites in different years, from differently aged trees. Further research is needed to determine how CT may vary in ***A. saligna*** in relation to the many factors that may influence it. Greater understanding of such factors might enable its potential source of fodder to be realised.

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TABLE 2
Intake and digestibility of *A. saligna* and straw offered to sheep with or without a supplement of 1% urea or PEG 4000.

	TREATMENT			SIGNIFICANCE
	CONTROL	+ PEG 4000	+ 1% UREA	
DMI (G/D)				
- Straw	75	72	82	NS
- *A. saligna*	(44)	(28)	(52)	
- Total	1287[a]	1389[b]	1295[a]	*
	(200)	(126)	(238)	
	1362[a]	1461[b]	1377[a]	*
	(175)	(107)	(205)	
DMD (%)	48.2[a]	55.2[b]	49.0[a]	*
	(2.6)	(4.7)	(2.8)	
OMD (%)	49.7[a]	56.6[b]	50.9[a]	*
	(2.4)	(4.6)	(2.5)	

**P <0.05; NS, not significant. Values within rows within different superscripts are significantly different. Values within brackets indicate standard deviations.*

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