

CAN THE VOLUNTARY FEED INTAKE OF WHEAT STRAW IN SHEEP BE IMPROVED BY MIXING WITH SALTBUUSH (*ATRIplexAMNICOLA*)?

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SUMMARY

In this study the effect of adding saltbush to a wheat straw diet on voluntary feed intake (VFI) of sheep is defined. Twenty mature Merino wethers housed in metabolism crates were fed diets of wheat straw and saltbush for 4 weeks. In general the mixing of saltbush with wheat straw had a positive effect on the VFI of sheep but little interaction was found between the 2 feeds. The apparent dry matter digestibility of mixed diets was higher than that of wheat straw except on the diet with 25% saltbush. The nitrogen intake and nitrogen retention of sheep increased with the addition of saltbush to wheat straw. Water consumption per unit of dry matter intake on mixed diets was similar to that on a wheat straw diets at 25 and 50% saltbush inclusion but increased at 75 and 100% inclusion.

Key words: sheep, voluntary feed intake, saltbush, wheat straw.

INTRODUCTION

In revegetation programs of saline soils of Western Australia (WA), saltbush (*Atriplex amnicola*) is regarded as valuable because of its tolerance to both drought and salinity. Saltbush leaves are apparently high in crude protein (CP, 12-18%). However, information on the voluntary feed intake (VFI) of sheep on diets containing saltbush is limited and equivocal. The VFI of sheep on pure saltbush diets is variable and ranges from 500 to 1000 gDM/day, probably because of the high salt content, and the need for a large quantity of drinking water (up to 13 mL/gDM.day) as compared to that required when grazing stubbles (2 mL/gDM.day for oaten hay; Warren *et al.* 1990). It might not be practicable to provide this much water under farm conditions.

During summer and autumn in WA cereal straws are an important feed resource, but are generally of poor quality. They are extremely low in nitrogen and concentrations of 0.2 to 0.8% in dry matter (1 to 5% CP) are common. Diets less than 7% CP are not readily eaten by ruminants (Doyle 1983). This suggests that saltbush and cereal straw might be used in conjunction to improve the nitrogen concentration of the diet and thus VFI.

Warren *et al.* (1990) reported that the VFI of oaten hay and *A. undulata* mixed in a ratio of 50:50 was 1479 gDM/day, much higher than the VFI of sheep on either oaten hay (892 gDM/day) or *A. undulata* (668 gDM/day). However, their study did not demonstrate the manner in which the constituents of the feeds interacted to improve utilisation, nor whether the 50:50 mix was the optimum. The objective of the present experiment was to define the response to adding saltbush (*A. amnicola*) to a wheat straw diet and to demonstrate the manner in which the constituents of the feeds might interact to improve the utilisation of both.

MATERIALS AND METHODS

Twenty mature Merino wethers (52-63 kg) were maintained indoors in metabolism crates. To determine individual variability in VFI the animals were fed a diet of wheat straw (72%), lupins (27%) and mineral mix (1%) for 4 weeks. After 2 weeks of acclimatisation their daily VFI was recorded for another 2 weeks. Animals were then stratified according to VFI and allocated to 5 treatment groups fed diets with varying proportions of wheat straw and saltbush (*A. amnicola*) (Table 1). The sheep were weighed at the commencement of the experiment and each week thereafter.

Wheat straw used in the diets was hammer-milled using a 25 mm screen. *A. amnicola* was collected at Tammin (180 km east of Perth) between August and September 1992, by hand stripping from shrubs about 3 years old. The material obtained consisted of 78% leaves, 8% seed and 14% stem, and the average diameter of the stem was 0.7 mm (range 0.3 to 1.5). All material was dried at 55°C for 48 hours and then stored. The wheat straw and saltbush were mixed thoroughly in a rotary mixer.

All diets were offered over 4 weeks with each day's offering being about 10% above the previous day's intake. Residues were collected daily and water consumption was recorded daily for 2 weeks. For the last 9 days of the experiment total faeces and urine were collected daily. Samples of rumen fluid to determine ammonia-nitrogen were taken by stomach tube at 0, 1, 2, 4, 8, 12 and 24 hours after feeding.

at the end of the nitrogen balance trial. Samples of feed offered, refusals and faecal material were ground through a 1 mm screen, and standard analytical procedures were used to determine neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin, ash, total nitrogen and sodium. The chemical composition of the diets is presented in Table 1. Differences between means were tested using analysis of variance.

Table 1. Experimental diets and their chemical composition (% DM)

	D1	D2	Diet D3	D4	D5
Wheat straw	100	75	50	25	—
Saltbush	—	25	50	75	100
Nitrogen	0.5	0.8	1.2	1.4	1.8
Ash	4.2	6.7	8.7	11.7	17.1
NDF	73.9	68.5	64.0	60.4	52.7
ADF	44.9	42.1	39.0	35.9	31.8
Lignin	4.6	5.8	7.6	8.7	10.1
Sodium	0.06	0.78	1.61	2.16	3.42

RESULTS

The dry matter intake (DMI) of sheep on the saltbush diet was higher ($P < 0.05$) than that on the wheat straw diet (Table 2). The apparent dry matter digestibility (DMD) of wheat straw was similar to that of the diet with 25% saltbush, but was lower than for the other diets ($P < 0.05$; Table 2). All sheep lost liveweight over the collection period with the loss being similar for all diets ($P > 0.05$).

The nitrogen retention of sheep on the saltbush and saltbush-wheat straw diets was similar but higher ($P < 0.05$) than on the wheat straw alone. The response to increased nitrogen intake in rumen ammonia, nitrogen in faeces and nitrogen in urine was linear ($r = 0.99$).

Although the variation between sheep and diets in daily water intake was high, the addition of saltbush to wheat straw generally increased water consumption of sheep, from 2546 mL/day on wheat straw diet to 9808 mL/day on pure saltbush diet. However, the ratio of water to dry matter intake was similar for diets containing 50% or less saltbush.

Table 2. Voluntary feed intake, digestibility and nitrogen balance of sheep fed different diets during collection period

	D1	D2	Diet D3	D4	D5	SED
Dry matter intake (g/day)	621 ^a	985 ^{ab}	1184 ^{bc}	1390 ^{bc}	1629 ^c	148.2
Dry matter digestibility (%)	42.1 ^a	45.5 ^{ab}	46.3 ^b	46.5 ^b	46.1 ^b	1.27
Digestible OM intake (g/day)	259 ^a	421 ^{ab}	502 ^b	561 ^b	602 ^b	61.4
Nitrogen intake (g/day)	2.9 ^a	8.5 ^{ab}	14.1 ^{bc}	19.6 ^c	30.6 ^d	2.30
Nitrogen in faeces (g/day)	3.6 ^a	5.8 ^{ab}	7.8 ^b	9.1 ^c	12.3 ^c	1.12
Nitrogen in urine (g/day)	2.6 ^a	3.0 ^a	6.0 ^{ab}	9.0 ^b	15.9 ^c	1.23
Nitrogen retention (g/day)	-3.3 ^a	-0.3 ^b	0.3 ^b	1.5 ^b	2.4 ^b	0.83
Mean rumen ammonia-N (mg/L)	6.1 ^a	14.0 ^{ab}	31.9 ^{bc}	45.9 ^c	66.7 ^d	5.05

OM = Organic matter, SED = Standard error of difference.
Averages within each row followed by different superscripts differ significantly ($P < 0.05$).

DISCUSSION

With the addition of 25% saltbush there was some supplementary intake of wheat straw, but at levels of saltbush above this substitution for wheat straw occurred and for the pure saltbush diet the DMI was significantly higher than wheat straw. This response is in contrast to that of Warren *et al.* (1990) who

reported a substantial increase in DMI of sheep when saltbush and oaten hay were mixed in a 50:50 ratio.

Such discrepancies might arise from differences in the preparation and species of saltbush used, or the quality of straw used. In the study of Warren *et al.* (1990) the harvested saltbush was dried and chopped through a chaff cutter and the diameter of the stem was up to 6 mm. In this study the leaves were hand stripped and the average diameter of the twigs was 0.7 mm. It is likely that physical factors like the larger stem diameter might have offered more resistance to breakdown during ingestion and rumination, and therefore responsible for the lower intake of saltbush but increased DMD in the Warren *et al.* (1990) study. The value of DMD for *A. amnicola* observed in this study (46%) was lower than that reported by Warren *et al.* (1990) for *A. amnicola* (57%) and *A. undulata* (53%), but higher than that reported by Pol (1980) for *A. undulata* (33%) which contained a high proportion of stem. Similarly the value of DMD for a 50:50 mix in this study (46%) was lower than that reported by Warren *et al.* (1990; 64%).

The DMI of sheep on the wheat straw diet in this study was 32.6 g/kg^{0.75}, whereas the DMI of oaten hay in Warren *et al.* (1990) was 43.9 g/kg^{0.75}, with the difference probably being due to higher levels of lignin but lower levels of CP in wheat straw than oaten hay.

An improvement ($P < 0.05$) in nitrogen retention was achieved by the addition of saltbush. However, urinary excretion of more than 50% of the extra nitrogen intake for diets with 50% or more saltbush suggests poor utilisation of the nitrogen in saltbush by rumen micro-organisms. This could be due to the low content of metabolizable energy both in saltbush (5-7 MJ/kg DM; Le Houerou 1992), resulting from the high level of ash and lignin, and wheat straw due to the high level of ADF (45%).

Mean rumen ammonia level on diets with 0 to 50% saltbush was far less than the 50 mg N/L considered necessary to maintain minimum microbial activity (Mercer and Annison 1976) and the peak values for these diets also remained less than 50 mg N/L. However, even when mean rumen ammonia level increased above this minimum level (D5, 67 mg N/L), the DMD of the diet did not improve. This suggests that the animals were tolerant to low rumen ammonia levels and that the low energy content of the diet may have been a problem.

Differences in chemical composition like the sodium content of saltbush can also influence DMI. The concentration of sodium in *A. amnicola* used in this study (3%) was lower than values reported in the literature and the 4.4% found by Warren *et al.* (1990). This was probably due to rainfall during the time when saltbush was harvested, which may have leached out some of the mineral elements because of the presence of bladder cells on the leaf surface which contain high concentrations of salt (Grice and Muir 1988). Because of the low sodium level in saltbush in this work, the water intake per unit of dry matter intake on saltbush and saltbush mixed diets was low (4-6 mL/g DM.day) compared to that of Warren *et al.* (1990; 13 mL/g DM.day).

The organic matter apparently digested (OMD) by sheep increased with an increase in saltbush in the diet. The OMD on the pure saltbush diet (602 g/day) should have been sufficient to meet maintenance energy requirements but all sheep in this group lost liveweight, on an average about 172 g/day. This may have been due to high energy requirement to excrete the increased daily load of sodium, as Arieli *et al.* (1989) have shown an elevated heat production by animals on a saltbush diet. Also with an experiment of this short duration liveweight changes might be unreliable, due to changes in gutfill associated with the very high intakes of water.

In conclusion, the present results demonstrate that saltbush can be used to improve the total DMI of sheep fed wheat straw and that an improvement in nitrogen retention can be achieved by adding at least 25% saltbush. However, the means by which this can be achieved under grazing conditions are yet to be determined.

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