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TOWARDS A BETTER UNDERSTANDING OF ANIMAL NUTRITION IN PASTORAL SOUTH AUSTRALIA

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ABSTRACT
Rangeland pastures are characterised by considerable variability in forage quality and supply. Grasses have poor nutritive value in summer and autumn, with insufficient energy and protein to maintain animals, while the high fibre content lowers feed intake. Shrubs such as saltbush and bluebush generally contain insufficient energy for maintenance, and the high mineral content of the leaf material carries a risk of toxicity. Annual broadleaf plants are nutritious when growing, but any stubble is deficient in both energy and protein. Sub-optimal nutrition leads to poor lambing success, retarding the infusion of improved genetics.

INTRODUCTION
The pastoral industry accounts for 20-25% of the nation's sheep population. Because of the seasonal and geographic variability in the pastoral zone, it is difficult to determine the quantities of different plants being consumed, as grazing animals are selective in their consumption of plants. Lynch *et al.* (1992) report that the most preferred species often are those with highest nutritive value (energy, protein, mineral and vitamins). However, animals may avoid species with nutrients in much greater supply than needed; for example, pastoral sheep avoid eating growing medics, which have a very high protein content. Overexploitation of a few species leads to an overall decline in overall pasture quality as the less preferred species will be at a competitive advantage. No plant species alone provides an adequate diet for grazing animals, so the balance of the whole diet is the key to ensuring nutrient requirements are satisfied.

In many cases, animal productivity (especially of breeding animals) does not correspond to assumed nutritive value of the species grazed, possibly because current data sets are limited, unreliable and/or incorrect. This project analysed the nutritive value of the main pasture species on a bi-monthly basis, allowing comparisons between seasons and locations. Ultimately, this project aimed to provide pastoralists with improved information on what their sheep graze, how nutritious these plants are, and how too optimise animal performance.

METHODOLOGY
This project involved sampling commonly grazed plant species on the four stations; "Woolgangi", "Weekeroo", "Middleback" and "Glenroy" in the central north-east pastoral zone of South Australia. Conventional plant sampling guidelines were followed, except for shrubs where only the stems finer than 1.5mm and the leaves were sampled (Atiq-ur-Rehman *et al.* 1999). Plant samples were sent to FeedTest, Victoria, for nutritive analysis. Nutritive data were compared to published animal requirements (Underwood & Suttle 1999; McDonald *et al.* 2002) to determine whether levels were within recommended guidelines.

Blood samples were collected from sheep on each property in Oct 2003 and February 2004 to determine the status of Ca, P, K, Mg, Zn, Cu, glutathione peroxidase (indicator of Se) and vitamin B12 (indicator of Co). Data obtained were compared to recommended blood concentrations supplied by the laboratories (IDEXX and Gribbles Pathology). Productive Nutrition P/L collated plant and animal data, and, where possible, statistical analyses were undertaken using GenStat 5.1.

RESULTS

115 plant samples were collected, and a summary of selected species' relative nutritional strengths and weaknesses appear as Table 1.

Table 1: The relative nutritional strengths and weaknesses of the main plant species in this study

"n" refers to the number of samples collected for each species. "xs" refers to nutrient levels that are far in excess of requirements, risking toxicity. CP = crude protein; ME = metabolisable energy; NDF = neutral detergent fibre

n	Species	Common name	Strengths	Weaknesses
4	*Atriplex nummularia*	Old man saltbush	High CP, ME	xs Cl, K, Mg, Na. Low NDF
7	*Atriplex* sp.	Annual saltbush	High CP	xs Cl, K, Mg, Na
12	*Atriplex vesicaria*	Bladder saltbush	High ME	xs Cl, Fe, K, Mg, Na. Low P, Zn
10	*Carrichtera annua*	Ward's weed	High CP, Ca	xs Fe
3	*Maireana georgii*	Sanity bluebush	High CP	xs Cl, Na. Low P, Zn
8	*Maireana pyramidata*	Black bluebush	High CP, Ca	xs Cl, Fe, Mg, Na. Low P, Zn
12	*Maireana sedifolia*	Pearl bluebush	High CP	xs Cl, Na. Low P, Zn
9	*Medicago sp.*	Medic	High CP, Ca	xs Al, Cu, Fe
3	*Myoporum platyoarpum*	Sugar wood	High ME	xs Cu. Low NDF, P, Zn
7	*Rhagodia sp.*	Rhagodia	High CP, Ca	xs Cl, K, Mg, Na. Low P, Zn
4*	*Sclerolaena ch., dia., eria.* *	Copperburr	High CP, ME, Ca	xs Cl, Fe, Na. Low P, Zn
3	*Sclerolaena obliquicuspis*	Limestone copperburr	High Ca	xs Na, Fe, NDF. Low P, Zn
4	*Sisymbrium erysimoides*	Mustard weed	High CP, ME, Ca	xs Fe, K, Na. Low NDF, P
6	*Soliva pterosperma*	Bindii		xs NDF, Al, Cu, Fe, Na. Low ME, P
6	*Stipa sp.*	Speargrass		xs NDF. Low ME, P, S, Zn
1	*Tetragonia tetragonoides*	Spinach	High CP, ME, Ca	xs Al, Cu, Fe, K, Na. Low NDF

[* Three *Sclerolaena* species were sampled over the course of the study; *S. chilicticapes, S. diachantha, S. eriacantha.* All had similar NV values so have been analysed together, but differ greatly to *S. obliquicuspis*]

Statistical analysis of the data found that most annuals had significantly higher CP and ME levels around September-October. In *Medicago* sp., NDF was around 35% during spring, rising to 60% as stubble (January). Similarly, CP levels were significantly higher during spring (27%) than as stubble (15%). The concentrations of Al, K, Mo, Na and Se varied between properties in various species.

Blood analysis determined that sheep on all four properties were hypocalcaemic (Table 2), with Ca levels ranging from 2.4-2.8 mmol/L, compared to the recommended minimum of 2.9 mmol/L. Blood K levels exceeded maximum recommended concentrations (5.4mmol/L) on almost all occasions. Glutathione peroxidase (GSH PX) was above the recommended maximum of 550U/gHb on all occasions, averaging 767U/gHb, and reaching 1045U/gHb at Weekeroo in November 2004. Cu and Mg were generally above the recommended minimum, while P and Vit B12 status was satisfactory on all occasions.

Table 2: Mean blood mineral content of sheep on the four properties
Ideal upper and lower limits provided by IDEXX Laboratories, Adelaide.

		Ca	**Cu**	**K**	**P**	**Mg**	**Zn**	***GSH PX***	**Vit B12**
Date	**Property**	mmol/L	μmol/:	mmol/L	mmol/L	mmol/L	μmol/:	U/gHb	pmol/L
Oct-03	**WOOLGANGI**	2.8	13.7	6.5	2.0	1.6		640	2555
Oct-03	**MIDDLEBACK**	2.6	14.5	5.2	1.7	0.9		596	2728
Oct-03	**GLENROY**	2.7	11.2	5.5	2.4	0.9		609	3475
Feb-04	**WEEKEROO**	2.8	15.8	6.8	2.3	1.1		624	2924
Mar-04	**MIDDLEBACK young**	2.6	18.1	5.7	2.1	0.9		972	1178
	MIDDLEBACK old	2.4	14.3	5.6	2.1	1.1		883	805
Sep-04	**GLENROY good condition**		6.5				18.9	615	>1500
	GLENROY poor condition		10.2				18.9	664	>1500
Nov-04	**WEEKEROO good cond.**		7.2				19.4	1017	>1500
	WEEKEROO poor cond.		6.3				17.6	1045	>1500
Nov -04	**WOOLGANGI poor cond.**		11.5				6.6	774	>1500
Nov-04	**WOOLGANGI good cond.**		9.4				6.9	605	>1500
	Recommended range	2.9-3.2	9-25	3.9-5.4	1.6-2.4	0.9-1.3	7-25	50-550	400-5000

DISCUSSION

The main seasonal trend observed in annuals and grasses was ME and CP to be highest in spring, and NDF to be highest in stubbles. Perennials, especially shrubs, maintain their NV most consistently throughout the year, highlighting the value of these plants as a reliable source of consistent quality fodder.

Nearly all rangelands are characterised by the presence of poisonous or toxic plants, varying from lethality to subclinical depressions in animal performance (O'Reagain & McMeniman 2002). While there do not appear to be any "toxic" plants in this study *per se*, the extremely high sodium (up to 6.6%DM), chloride (up to 6%DM) and potassium (up to 4.5%) levels in plants such as *Atriplex, Maireana* and *Rhagodia* present the grazing animal with a serious mineral challenge. Sheep can tolerate dietary salts by virtue of renal adjustment, but it increases basal energy requirements (Potter 1961). Feed intake is also restricted if the diet is high in salt (above 2%). The apparently high ME content of the *Atriplex* species in this project (e.g. 11.1MJ ME/kgDM in *A. nummularia*) may not be entirely accurate, as their high mineral content affects the current laboratory analytical process. Few published studies recognise this, and therefore many assessments of the energy content of halophytes may be overestimated.

The low blood calcium levels in these sheep are cause for concern, especially considering most of the plant species contain reasonable calcium concentrations, and the sheep were all dry when sampled. No plants were actually deficient in Ca, but there are two possible reasons for low blood calcium in these sheep; (1) high dietary Na and K leading to excessive renal filtration of minerals, or (2) high oxalate levels in *Atriplex* and *Maireana* – oxalate complexes with calcium in the blood, making it unavailable and leading to kidney damage.

The high plasma GSH PX, while much higher than recommended levels, are not indicative of toxic selenium intake as no pasture species contained toxic levels of selenium. Overall, plasma Zn levels were good, but many plant species were Zn deficient, including the common plants such as *Maireana*, *Sclerolaena*, *Stipa* and *Rhagodia*. Zn deficiency is associated with sub-optimal growth and poor fertility. The slightly high copper levels in some plants carry the risk of chronic copper toxicity (Howell 1996). Plasma copper levels were generally within normal ranges. Cobalt levels in the plants (up to 2.72mg/kgDM) were within the acceptable range, given the wide tolerance of ruminants to Co. Co is an integral component of Vitamin B12, and plasma Vitamin B12 levels were ideal. Despite more than half the plant species in this study being P deficient, plasma P levels were actually quite high. The plants highest in P were *Medicago* and other forbs, highlighting the value of these plants. The high plant aluminium levels may be affecting feed intake. Underwood & Suttle (1999) report that a dietary concentration above 2g Al/kgDM depresses appetite in lambs, but at this level is not associated with clinical abnormalities during two months of exposure. Given that Al levels in some species in this study are up to three times greater than this, it is probable that high dietary Al is having some affect on feed intake and possibly animal performance.

Sheep fertility rates in pastoral areas are compromised when the ability to forage is reduced. In addition, pregnant and lactating ewes, and therefore the foetus and the lamb, suffer from heat stress, lack of shade and inadequate nutrition around the time of lambing (Cobon *et al.* 1994). It is evident that supplementary feeding of sheep in pastoral South Australia is likely to increase lambing percentages and reduce ewe losses. The key nutrients to provide pregnant and lactating ewes, and their lambs, are energy and calcium. Supplementary feeding with phosphorus and zinc may also be useful, since so many of the pasture plants are deficient in these minerals, although plasma levels generally satisfactory.

CONCLUSIONS

It is apparent that no single pasture species provides a satisfactory diet, but most species contribute positively to animal performance. Low blood calcium is certainly a cause for concern, especially in breeding ewes, and so are the high levels of salts, especially sodium and potassium, in the plant material. The low energy content of many species certainly limits animal growth and production, and prevents the full expression of steadily improving sheep genetics; it is a matter of feeding the genetics. Optimising management of the livestock component of these systems is imperative because the animals are the major economic part of the system, highlight the importance of better understanding pastoral animal nutrition.

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