

## LIVEWEIGHT AND WOOL RESPONSES IN WETHER SHEEP TO A LONG TERM MINERAL SUPPLEMENT

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### Summary

Merino wether sheep grazing improved annual pastures in a Mediterranean environment were offered a multi-element mineral mix for four years, with urea added in the last three years. Control sheep received no mineral mix or urea, but both control and treated sheep were given selenium and cobalt pellets. The aim of the experiment was to determine whether the mineral supplement would have any deleterious effects on the health or productivity of the sheep if consumed for a long period.

The treated sheep ate an average of 25 g/head/day of the mineral mix and showed no ill effects compared with control sheep. Over the four years they produced 11.6% more clean wool ( $P < 0.05$ ), and were significantly heavier than control sheep in two out of four years. These results show that the mineral supplement was not having any detrimental effects on sheep health, but on the contrary was responsible for increased productivity.

**Keywords:** mineral mix, sheep, wool, liveweight, staple strength.

### INTRODUCTION

The concentrations of several macro and micro minerals in dry improved pastures in SW Australia are below levels recommended for grazing sheep (SCA 1990, White *et al.* 1992). In order to determine the likely impact of these on the productivity of grazing sheep, we developed a multi-element mineral mix, Siromin<sup>®</sup>, for use during the dry summer period (Masters *et al.* 1992, White *et al.* 1992). When tested over the summer at the CSIRO or Agriculture WA research stations in Western Australia the mineral mix increased liveweight, fleece weight and staple strength in sheep by up to 13%, 9% and 40%, respectively (White *et al.* 1992, White and Fortune 1993, Kumagai and White 1995).

The use of a multi-element mix is not without potential risks, however. For example, Siromin contains fluorine as a contaminant, and although it poses no discernible risk when fed to weaners for six months (Masters *et al.* 1992) little is known of any possible long term cumulative effects.

The following experiment was designed to test whether sheep offered Siromin for an extended period would show any impairment in health or production. In this paper we report on the pattern of mineral consumption and on the effect of the supplement on sheep health, liveweight and wool production when fed continuously for four years. The concentration of sulfate-sulfur in plasma was used as an indicator of the short term variation in mineral intake between animals (White *et al.* 1997).

### MATERIALS AND METHODS

The experiment was carried out at the Yalanbee research station, 75 km E of Perth in Western Australia. A description of the climate and pasture has been given elsewhere (White *et al.* 1992). All experimental plots had received an annual top-dressing with superphosphate at 100 kg/ha for at least five years prior to the experiment. In the first year of the experiment they were top-dressed with 100 kg/ha of superphosphate containing 0.6% copper, 0.3% zinc and 0.06% molybdenum. The superphosphate contained 8.3% phosphorus and 10.1% sulfur (CSBP Pty Ltd).

The experimental design was two treatments x four replicates x four blocks. The replicates were one ha plots carrying 10 sheep each at the start. Treatments consisted of control (no mineral mix) or minerals (Siromin in troughs, replenished at fortnightly intervals). The mineral mix was supplied *ad libitum* in the first year and restricted thereafter to between 25 and 37 g/head/day. Based on previous measurements, 25 g/day meets the mineral needs of sheep grazing dry improved pastures.

The mineral mix contained (g/kg) Na 169, K 99, Ca 65, S 46, P 16, Mg 4, (mg/kg) Fe 3800, Mn 660, Zn 940, Cu 120, Co 75, B 26, Mo 36, Ni 18, V 14, Cr 11, Se 5. Urea (10 kg per 100 kg Siromin) was added from January 1991 onwards when we became aware that farmers were adding urea to their mineral mixes and we wished to assess its safety in combination with Siromin.

At the start of the experiment, 10 weaner wether sheep of mean liveweight 34 kg were allocated to each of the eight plots. They were given a selenium and cobalt intra-ruminal pellet in March 1990. These core sheep were weighed and two were killed from each plot each year, leaving four core sheep that had been in the experiment from start to finish. Kidneys were examined for stones (urolithiasis), and teeth for signs of staining or excessive wear (fluorosis). Replacement sheep of equivalent age were used to maintain the grazing pressure and mineral intake, but were not included in the data analysis. Total sheep numbers on each plot varied from 7 to 14 depending on the time of year. The experiment lasted four years, from November 1989 to December 1994. Apart from the supply of the mineral supplement fortnightly, the sheep were managed as part of normal farm practice.

Fleeces were weighed and mid-side wool samples were taken at shearing in each September for measurement of yield, staple length, fibre diameter and staple strength by the Australian Wool Testing Authority at Fremantle. Blood samples were taken at several times throughout the experiment and the plasma analysed for sulfate using a barium sulfate turbidometric method (Cobas® clinical analyser).

Statistical analysis of liveweights and wool characteristics was by ANOVA on plot means using the micro-computer program Systat-5 (Systat Inc, Evanston, Ill).

## RESULTS

Sheep increased their intake of minerals slowly during the first few weeks and by June of the first season they were eating up to 56 g/head/day when the mineral mix was offered *ad libitum* (Figure 1). Note that this peak is diminished in the figure because the points are averaged. In 1991 intake was restricted because of fears of possible fluorosis and sheep left residues mainly during the winter and spring but ate most of what was offered during late summer and autumn. Mean intake was  $25 \pm 2$  g/head/day and mean amount offered was 34 g/head/day. Allowing for a six week period of adaptation, the mean coefficient of variation (between plot means) for intake was 11% over the 4 years.

The concentration of plasma sulfate-sulfur was significantly higher for sheep offered the mineral mix than for the control sheep (Figure 2; repeated measures ANOVA,  $P < 0.001$ ). The percentage of sheep fed the mineral mix and with low plasma sulfate concentrations ranged from 0% to 25% for the seven sampling times. Low concentrations are defined as values for supplemented sheep that were below the mean of control sheep at a particular sampling time. These sheep presumably had not eaten any mineral mix for several days prior to sampling. However, there were no individual sheep that repeatedly had low plasma sulfate concentrations, indicating that all sheep at some time ate some of the mineral mix.

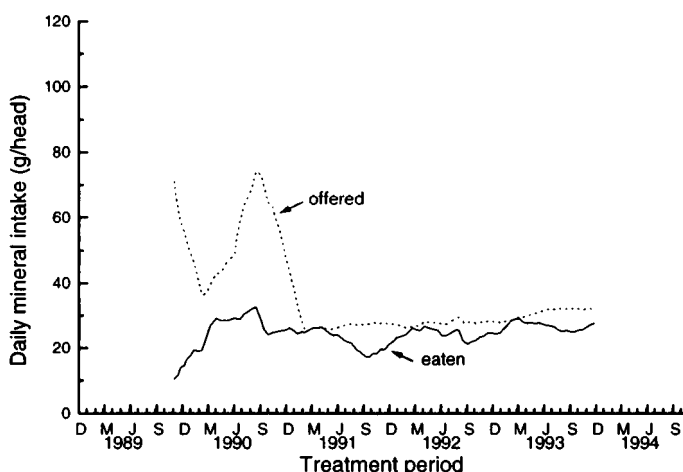
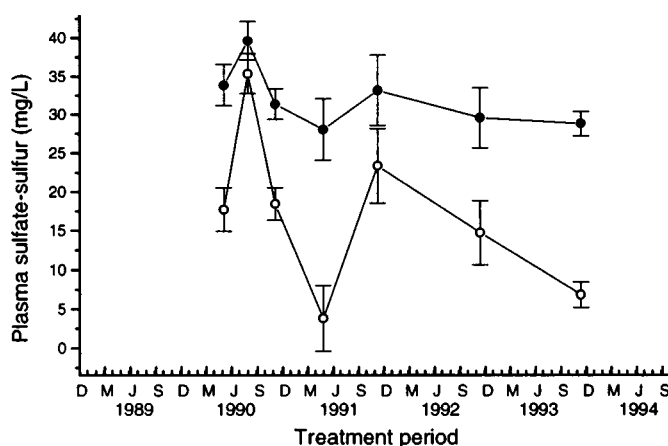


Figure 1. Consumption of the mineral mix by sheep during the treatment period (solid line) compared with amount offered (dotted line). The difference between the lines represents residues. Data are smoothed using a moving 10 point average (D, December; M, March; J, June; S, September).



**Figure 2.** The effect of mineral treatment on the concentration of sulfate-sulfur in plasma. Symbols are open circles for control sheep ( $n = 11$ ) and solid circles for those offered the mineral mix ( $n = 12$ ). Values are least squares means  $\pm$  s.e.m. for individual sheep.

In terms of sheep health, a total of eight sheep died during the experiment, five within the first three months. Six sheep were from control plots and two from mineral plots. The cause of death was never identified because the carcasses were decomposed at the time of discovery, but fly strike was suspected because six deaths occurred in spring and a further four sheep were struck and survived, one on a control plot and three on mineral plots. One sheep from a control plot had small (less than 1mm) kidney stones when killed in year four but there were no stones seen in other sheep. There was no evidence of fluorosis (excessive teeth wear or teeth discolouration) in sheep on mineral plots. Worm egg counts in faeces were low in all sheep ( $<50$  eggs/g).

Sheep offered the mineral mix were significantly heavier than control sheep in two of the four years (Table 1). Similarly, clean fleece weights were up to 13% heavier in the mineral group and the differences were significant in two out of four years (Table 1). Staple strength was up to 19% higher in the mineral group but the probability values were above 0.05. Fibre diameter reflected fleece weight differences but the treatment effects were not significantly different.

**Table 1.** Liveweight in November of each year and fleece characteristics at shearing (plot mean  $\pm$  s.e.m.). Plot means were derived from the four sheep that were present for the entire experiment.

	Year 1	Year 2	Year 3	Year 4
<i>Liveweights (kg):</i>				
Control	58.0 $\pm$ 1.5	65.3 $\pm$ 0.50	74.1 $\pm$ 0.26	77.9 $\pm$ 4.0
Mineral	58.7 $\pm$ 1.5	68.4 $\pm$ 0.50	75.4 $\pm$ 0.26	79.8 $\pm$ 4.0
ANOVA - P	0.20	0.02	0.04	0.16
<i>Clean fleece weight (g):</i>				
Control	2941 $\pm$ 142	3236 $\pm$ 82	3421 $\pm$ 90	3947 $\pm$ 180
Mineral	3199 $\pm$ 142	3626 $\pm$ 82	3878 $\pm$ 90	4421 $\pm$ 180
ANOVA - P	0.29	0.04	0.04	0.16
<i>Staple strength (N/kt):</i>				
Control	22.7 $\pm$ 1.54	31.7 $\pm$ 2.19	44.1 $\pm$ 4.41	45.1 $\pm$ 3.00
Mineral	26.5 $\pm$ 1.54	37.6 $\pm$ 2.19	45.1 $\pm$ 4.41	44.1 $\pm$ 3.00
ANOVA - P	0.18	0.15	0.88	0.82
<i>Fibre diameter (mm):</i>				
Control	20.7 $\pm$ 0.33	21.5 $\pm$ 0.30	21.3 $\pm$ 0.25	22.0 $\pm$ 0.27
Mineral	20.8 $\pm$ 0.33	21.9 $\pm$ 0.30	21.8 $\pm$ 0.25	22.9 $\pm$ 0.27
ANOVA - P	0.84	0.42	0.23	0.27
<i>Staple length (mm):</i>				
Control	101.7 $\pm$ 1.8	101.4 $\pm$ 1.1	97.0 $\pm$ 2.9	101.2 $\pm$ 2.0
Mineral	103.8 $\pm$ 1.8	101.9 $\pm$ 1.1	95.3 $\pm$ 2.9	99.1 $\pm$ 2.0
ANOVA - P	0.46	0.80	0.71	0.51

## DISCUSSION

The results show that the continuous provision of a multi-element mineral mix to sheep for four years, three with urea, had no cumulative adverse effects on animal health, liveweight, fleece weight or objectively measured fleece characteristics. In fact the sheep showed significant positive responses to the supplement in several years. It is not clear whether the response was to urea or minerals or both, but the size of the wool response was similar to that seen previously with just minerals in ewes and weaners in short term experiments (White *et al.* 1992, Kumagai and White 1995).

The average per head consumption of 25 g/day of the mixture was close to that estimated to meet the mineral requirements of sheep grazing dry annual pastures in Western Australia (White *et al.* 1992). Sheep ate all of the mix during the late summer, and at this time were willing to eat significantly more than 25 g if given the opportunity. There was a tendency for sheep to eat less of the mix during the wetter months, perhaps due to excessive wetting of the mix by rainfall entering under the cover, or to the fact that sheep were less inclined to eat minerals when feed supply was plentiful. The between-animal and between-plot coefficient of variation in intake varied with time of year but was less than 25% overall. The main point regarding between-animal or between-plot variation in intake is that sheep require a period of adaptation to a novel food and in this experiment it took several weeks to plateau. The failure to allow for this adaptation may account for some previously reported high values for between-animal variation in intake (Rocks *et al.* 1982; Money *et al.* 1986). The sulfate results indicated that individual sheep were not consistently refusing the mix, but a more detailed analysis of mineral concentration in bones and tissues is needed to determine the range in intakes.

The 17% to 19% increase in staple strength in some years (albeit with  $P < 0.2$ ) and up to 13% increase in clean fleece weight, with a non significant increase in fibre diameter is consistent with the hypothesis that sheep in the environment of this experiment cannot meet their nutrient needs for wool growth from pasture without mineral and/or urea supplementation.

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