THE EFFECT OF INGESTION OF COAL MINE PIT WATER ON THE PRODUCTIVITY OF PREGNANT AND LACTATING BEEF COWS

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SUMMARY
This study examined the tolerance of pregnant and lactating beef cattle to elevated concentrations of sulphate (630, 1270 and 1910ppm sulphate) and other minerals in the drinking water. Feed intake, cow weight change during the first 12 weeks of lactation, calf growth rate and return to oestrus activity were all reduced appreciably when sulphate concentration was increased from 639 to 1270ppm. The study highlighted the greater sensitivity of breeding females, compared with published data for steers, to elevated concentrations of sulphate in the drinking water. It had been shown previously that steers could tolerate concentrations of up to 2000ppm without production loss. Further, the study provides evidence to support the Australian recommendation that 1000ppm sulphate should be the upper limit for sulphate concentration in the drinking water of cattle.

Keywords: mineral intake, coal mine water, lactating cattle

INTRODUCTION
In a number of locations in Australia, open cut coal mining and beef production coexist. Both subartesian water and rain water accumulate in the pits of open cut coal mines, resulting in high levels of minerals in the form of sulphate, chloride, and metal ions such as sodium, calcium and magnesium. During periods of drought, the availability of drinking water is of premium importance for grazing cattle. Experiments in steers, under good nutritional conditions, have shown that consumption of diluted pit water containing sulphate at levels lower than about 2000ppm was not associated with any reduction in feed or water consumption or rate of liveweight gain (Harper *et al.* 1997). Lactating cows have higher intakes of water than for steers and therefore have a greater potential for production to be adversely affected by excessive mineral intake. The aim of this experiment was to determine the effects of consumption of diluted coal mine pit water on the performance of pregnant and lactating beef cattle and growth rate of their calves.

MATERIALS AND METHODS
The oestrus cycles of 91 crossbred cows (¼ Africander x ¼ Brahman x ¼ Hereford x ¼ Shorthorn) aged approximately 3 years, were synchronized by the administration (i.m.) of prostaglandin just prior to them being joined with fertile bulls. The cows were held under grazing conditions at the National Cattle Breeding Station 'Belmont' near Rockhampton until about 10 weeks prior to the estimated date of parturition for the first cow. At this time the cows were diagnosed for pregnancy by rectal palpation and 24 of those found to be pregnant transported to the animal house at the J.M. Rendel Laboratory. The cows were treated with a commercially available anthelmintic (Nilverm, ICI Australia) when they first entered the animal house, and were confirmed to be free of external parasites by visual inspection.

Table 1 Mineral composition (mg/kg) of Rockhampton town water and diluted coal mine pitwater

	Rockhampton Town Water	630ppm sulphate	1270ppm sulphate	1910ppm sulphate
Chloride	≈ 52	998	2032	3056
Calcium	≈ 17	86	174	262
Magnesium	≈ 10	159	323	487
Sodium	≈ 30	336	684	1029

Cows were fed a mixture of long-chopped Rhodes grass (*Chloris gayana*) hay (N, 11.5; 5, 1.9; Ca, 2.6; Mg, 1.4; Na, 9.5; Cl, 17.5 mg/kg DM) with a minor inclusion of lucerne (*Medicago sativa*) hay *ad libitum* through late pregnancy and for the first 12 weeks of lactation. Intake was measured daily. They were allocated to one of four treatment groups (n=6) so that the range in live weight for each group was similar. Each treatment group was housed together in a 5 m x 12 m pen in a roofed animal house.

Drinking water was provided in troughs and intake recorded daily. Groups were allocated at random to one of 4 sulphate concentrations in the drinking water: control (Rockhampton town water, 21ppm sulphate), 630 ± 50, 1270 ± 60 and 1910 ± 60ppm. Sulphate was chosen as the reference solute because of its relatively high concentration in pit water. The concentration of sulphate in water was determined turbidimetrically according to the procedures described by Mottershead (1971).The concentrations of other minerals were determined by the methods described by Robertson *et al*. (1996). These concentrations are reported in Table 1 along with average historical values for town water obtained from the Rockhampton City Council. Procedures for transport and storage of pit water and its preparation for experiments with cattle were described by Harper *et al*. (1997).

Table 2. Productivity of cows drinking water of different sulphate concentrations

	Control	630ppm sulphate	1270ppm sulphate	1910ppm sulphate	SEM	Significance
Cow weight at parturition (kg)	556	527	537	528	23.5	ns
Calf weight at birth (kg)	32	32	32	30	1.63	ns
Mean milk yield (kg/d)	6.5	6.6	5.7	5.5	0.35	ns
Cow weight at calf weaning (kg)	568[a]	530[a,c]	506[a,c]	475[b,c]	21.2	*P*<0.05
Cow weight change during the first 12 weeks of lactation (kg)	12[a]	3[a]	-31[b]	-53[c]	7.1	*P*<0.05
Calf weight at 12 weeks of age (kg)	106[a]	103[a]	95[a,c]	82[b,c]	5.8	*P*<0.05
Cows returned to oestrus during lactation	3	3	2	0	-	n.s

[a, b, c] Values with different superscripts within a row differ significantly (P<0.05)

Live weight of cows and calves were measured once a week before feeding. Liveweight change was measured by linear regression analysis over 4 successive weekly measurements. Cows calved over a period of 4 weeks. Milk yield of cows was measured during the 2nd, 4th, 6th and 12th week of lactation using the weigh-suckle-weigh technique and the procedures used were described in detail by Hunter and Magner (1988).

The return of cows to cyclic oestrus activity was monitored using plasma sampling and progesterone radioimmunoassay (Amerlex-M, Amersham Aust.). Plasma values over background by 2 nmol/L were taken to indicate a return to oestrus activity.

This experimental protocol was approved by the local CSIRO Animal Ethics Committee.

Statistical analysis

The statistical significance of treatment differences between the various parameters was determined by analysis of variance (ANOVA) with one factor (treatment). For parameters measured on more than one occasion during the experiment a repeated measures ANOVA was used. A least significant difference test was used to identify the difference between individual treatment means. The differences in number of cows returning to oestrus activity was determined by chi-squared analysis. Values are reported as a mean and standard error. Statistical Analysis System computer software (SAS 1988) was used for these analyses. Means were considered to be significantly different when *P*<0.05

RESULTS

Cow live weight 4 weeks before parturition and liveweight change over the 4 pre partum weeks for control cows (581±21kg, 0.15±0.1kg/d) was not significantly different from cows offered pit water containing 630 (550±24 kg, 0.09±0.2 kg/d), 1270 (523±21 kg, 0.26 kg/d) or 1910 (563±26 kg, -0.03 kg/d) mg sulphate/L. Feed and water intake of control cows, and cows offered the various concentrations of pit water are presented in Figures 1 and 2. The differences in feed and water intakes between treatment groups could not be tested statistically because voluntary feed and water intakes were measured on a group basis. These differences in feed intake were associated with significant (P<0.05) differences in weight gain of the cows during the first 12 weeks of lactation (Table 2). Cows drinking water of the lower two sulphate concentrations gained weight during this period, whereas cows on the higher two concentrations lost more than 30 kg.

Milk yield was not significantly affected by treatment, through a trend for decreasing yield with increasing sulphate concentration was apparent. When milk yield of cows consuming pit water containing 1270ppm sulfate or greater was compared to cows consuming water containing 630ppm sulfate or less, the difference approached significance ($P = 0.06$).

Birthweight of calves from control cows was not significantly different to that for calves born to cows offered higher concentrations of sulphate in the drinking water (Table 2). There were significant ($P<0.05$) reductions in calf growth rate as pit water content of drinking water increased.

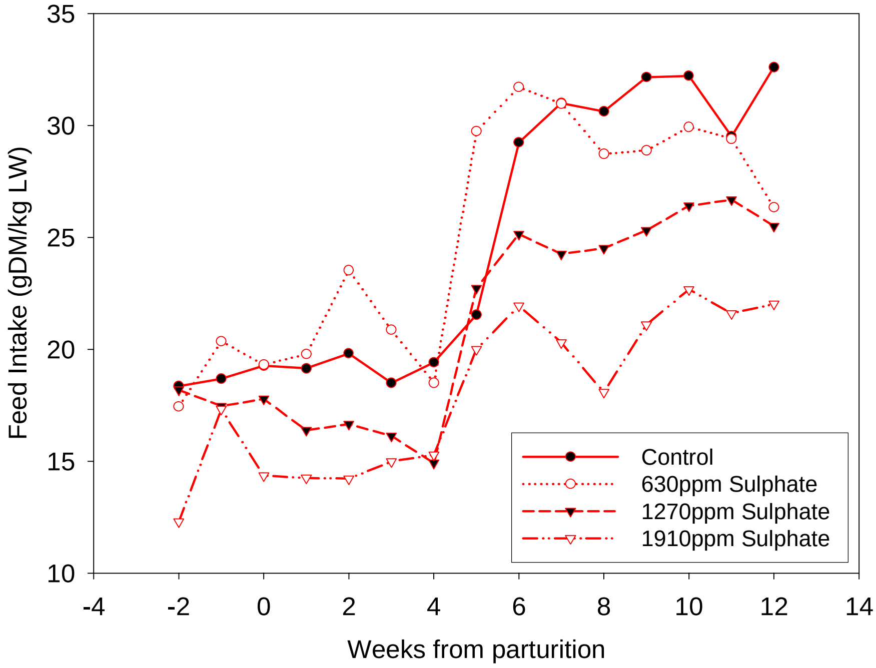

Figure 1. Feed intake of cows offered Rockhampton town water and diluted coal mine pitwater (DM, dry matter; LW, live weight).

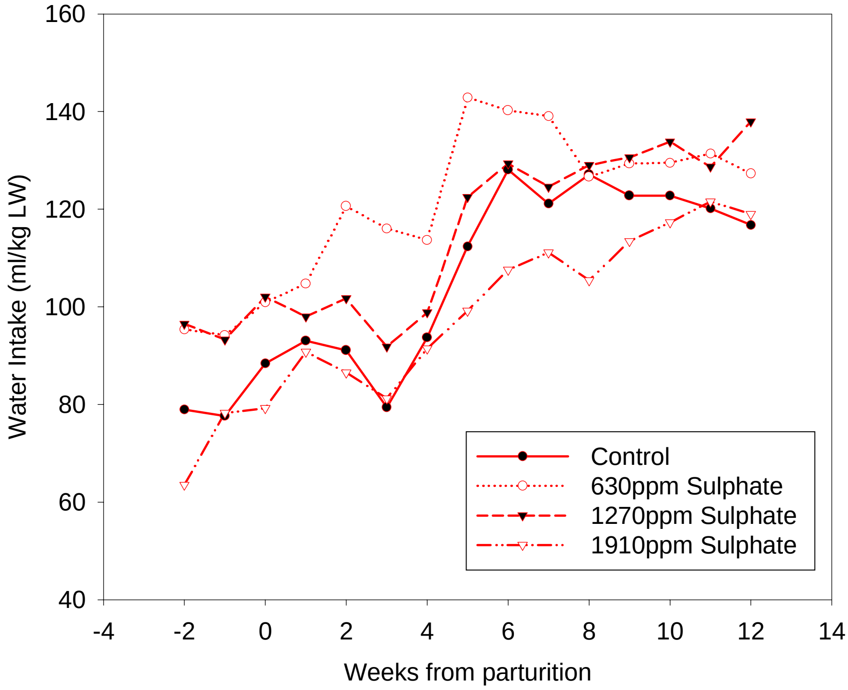

Figure 2. Water intake of cows offered Rockhampton town water and diluted coal mine pitwater (DM,dry matter;LW,live weight).

DISCUSSION

The results of this study provide evidence to support recommendation that 1000ppm sulphate is the upper limit of tolerable concentration for cattle (ANZECC 1992). It also highlights the reduced tolerance of breeding cows compared to published data for steers. Based on the results from a number of experiments Harper *et al*. (1997) concluded that water intake, feed intake and liveweight gain were not adversely affected in steers drinking up to 2000ppm sulphate in the drinking water. The present study demonstrated that productivity of breeding cows was adversely affected when sulphate concentration was increased from 630 to 1270ppm.

Robertson *et al.* (1996) suggested that the prime determinant of tolerance to high sulphate drinking water might not be the concentration in the water but the tolerable load of sulphur being added to the rumen pool. In one of the experiments reported by Harper *et al*. (1997) steers fed a high quality roughage had the same water intake at sulphate concentrations of 1000 and 2000ppm. The ingestion of sulphate by the steers drinking the higher concentration of sulphate in the diluted pitwater was 260mg/kg live weight. This was in excess of the sulphate load by lactating cows in the current experiment (229mg sulphate/ kg live weight). Comparisons with other studies in which sulphate and other mineral enriched drinking water was offered to lactating cows (Bahman *et al.*1993; Solomon *et al.*1995) lead to the conclusion that the reduction in water intake, feed intake and productivity may be related to the total mineral load rather than the reference solute, sulphate *per se*. It needs to be noted that the diluted pit water offered in the present study also contained elevated concentrations of other ions, especially chloride.

The results of this study are consistent with the suggestion that lactating cows are less tolerant to elevated sulphate concentrations in the drinking water than steers, and that this lesser tolerance needs to be considered when framing national water quality guidelines.

ACKNOWLEDGEMENTS

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