

WASTE MINIMISATION IN THE AUSTRALIAN FEEDLOT INDUSTRY : A PERSPECTIVE WITH REGARD TO SALINITY PARAMETERS OBSERVED IN COMMERCIAL FEEDLOTS

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SUMMARY

High salinity levels in feedlot manure may impact on the environment. Development of waste minimisation programmes requires current knowledge of existing saline inputs into feedlots (via ration and drinking water) and the subsequent effects on manure values. A survey of 11 commercial feedlots in southern Queensland has provided baseline information on salinity parameters and shown significant ($P < 0.01$) positive correlations between drinking water and faecal EC ($r = 0.594$), drinking water and faecal Na ($r = 0.743$), ration and faecal Na ($r = 0.667$) and faecal and pen manure Na ($r = 0.768$). Source used for stock drinking water is a significant factor in water quality, with bore water samples having significantly higher ($P < 0.05$) levels of salinity and Na compared to surface water and bore/surface water mixtures. The implications of these results with regard to waste minimisation are discussed.

Keywords: feedlot cattle, salinity, manure, ration, water quality

INTRODUCTION

Manure generated by cattle feedlots is ideally seen as a resource, comprising nutrients and organic matter recycled within agricultural production systems. However, intensification of the feedlot industry can create excess manure loads that then constitute a waste product. Recently, Watts (1992) documented environmental aspects of cattle feedlots in Australia, categorising a major area of potential impact as the degradation of surface waters, groundwaters and soil profiles. High salt levels in feedlot manure can contribute to deterioration of soil structure, and induce detrimental effects on both crop and aquatic fauna and flora. Saline inputs into a cattle feedlot system are primarily via rations and drinking water (Shuyler *et al.* 1975; Gardner *et al.* 1994); however there is a scarcity of information on ration and drinking water composition and associated effects on manure characteristics as applicable to Australian feedlots. Such data have important implications with regard to the design of ecologically sustainable manure disposal areas (Gardner *et al.* 1994).

A feedlot survey was initiated in southern Queensland to quantify such information and elucidate relationships between cattle nutrient inputs and manure composition indicative of the Australian feedlot industry. Presented in this paper are preliminary results for observed relationships between water and ration inputs and faecal and manure levels of salinity and sodium (Na).

MATERIALS AND METHODS

During the period late January to late February 1995, 11 commercial feedlots in Southern Queensland (26-29° S and 149 -153° E) were surveyed to obtain basic feedlot data and collect representative samples of drinking water, ration, faeces (freshly voided) and pen manure (loose surface material comprising old and new faeces and urine residue). The feedlots chosen comprised combinations of grainfed domestic and export cattle production and were considered representative of the ration types and management systems used in Southern Queensland.

Sample collection

Sampling occurred on a 'pen' basis with 2 pens per feedlot sampled on 2 occasions (week 1 and week 4 over the survey period). Ration samples were obtained from feed troughs, with drinking water samples obtained direct from water troughs. Faeces and pen manure samples were collected from transects taken within the pen, based on a protocol used by Lott *et al.* (1994).

Chemical analyses

Electrical conductivity (EC) and total dissolved ions (TDI) are used as expressions of salinity, and increase with increased salt concentration. Salinity and Na levels were determined in drinking water based on standard methods for water quality analysis (APHA, WPCF, AWWA 1985). The EC in faeces was determined using a TPS™ Model LC84 conductivity meter following a 1:5 dilution (1 part faeces (dry basis): 5 parts de-ionised water; 1000 $\mu\text{S}/\text{cm} = 1 \text{ dS}/\text{m}$). Ration, faecal and manure Na levels were

determined using inductively coupled plasma mass spectrometry (ICP-MS) based on the method described by Beauchemin *et al.* (1988).

Statistical analyses

Correlation coefficients were calculated to measure the strength of the linear relationship between the input and output parameters for a sample type. The chemical measurements were compared for the 3 different water sources by analysis of variance using Genstat V (Lawes Agricultural Trust 1994). The data was log transformed to stabilise the error variance.

RESULTS

The results presented in this paper are for both collection periods combined, as the effect of collection period was not significant.

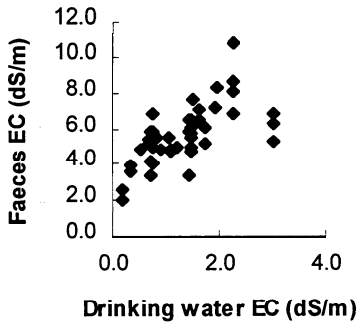


Figure 1. Observed relationship between drinking water EC and faeces EC (n=46)

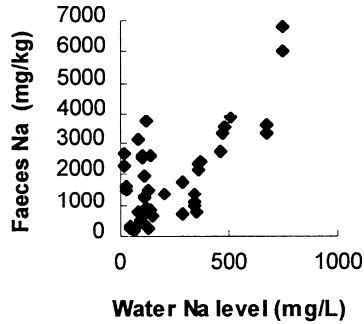


Figure 2. Observed relationship between drinking water Na and faeces Na content (n=46)

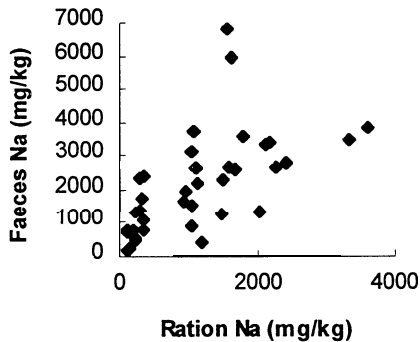


Figure 3. Observed relationship between ration Na and faeces Na content (DM basis, n=40)

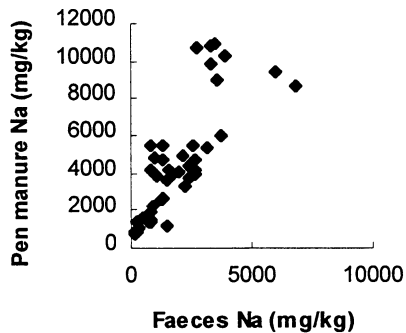


Figure 4. Observed relationship between faeces Na and pen manure Na content (DM basis, n=46)

Significant ($P < 0.01$) positive correlations were recorded for relationships between drinking water and faecal EC ($r = 0.594$, Figure 1), drinking water and faecal Na ($r = 0.743$, Figure 2), ration and faecal Na ($r = 0.667$, Figure 3) and faecal and pen manure Na ($r = 0.768$, Figure 4). Mean values (expressed as mean \pm SD) for each sample type were: drinking water EC, 1.3 ± 0.67 dS/m; faeces EC, 5.7 ± 1.57 dS/m; drinking water Na, 212 ± 177.4 mg/L; ration Na, 1090 ± 908.5 mg/kg; faecal Na, 1899 ± 1488.6 mg/kg; pen manure

Na, 4321 ± 2983.1 mg/kg. The Na composition of manure (DM basis) is proportionally higher than that of faecal material as a result of manure organic matter decomposition during accumulation on the pen surface.

Comparisons of salinity and Na levels in the 3 types of water sources used by feedlots for stock drinking water (ie bore water, surface water, or a mixture of both bore and surface water) are presented in Table 1. Bore water was significantly higher in TDI, EC and Na content than both surface and mixture water sources. Surface and mixture water sources were not significantly different in the parameters measured, with the exception of TDI content (Table 1). Salinity and Na levels recorded for mixture drinking water suggests that this water source was probably proportionally higher in surface water content than bore water content.

Table 1. Values for total dissolved ions (TDI, mg/L), electrical conductivity (EC, μ S/cm) and sodium (Na, mg/L) measured in drinking water sources for feedlots

	n	log TDI	Equivalent mean TDI	log EC	Equivalent mean EC	log Na	Equivalent mean Na
Bore water	30	7.03 ^a	1134.5	7.35 ^a	1553.0	5.35 ^a	210.1
Surface water	8	5.78 ^c	322.7	6.28 ^b	532.2	3.96 ^b	52.7
Mixture ^A	8	6.24 ^b	514.2	6.60 ^b	732.2	4.68 ^b	107.6
LSD (P < 0.05) ^B		0.449		0.473		0.790	
LSD (P < 0.05) ^C		0.357		0.376		0.628	

^A Comprising both surface and bore water.

^B For comparisons of surface v mixture.

^C For comparisons of bore v surface and bore v mixture.

Values with different superscripts differ significantly (P < 0.05).

DISCUSSION

Faecal salinity and Na levels were significantly correlated to respective water quality (salinity, Na) and ration Na content in the commercial cattle feedlots participating in this study. In addition, manure Na levels strongly reflected faecal Na content. Ingestion of saline water modifies animal retention and excretion rates of minerals such as Na, with increasing excretion rates with increased salinity in water (Marai and Habeeb 1994). The amount of salt ingested in drinking water is a function of the salinity levels (mg/L) and water consumption by the animal. In this study, values recorded would suggest that saline water intakes exceeding 2000 mg/L could occur (expressing salinity as a conversion factor of EC (dS/m) x 640; Gardner *et al.* 1994). A Japanese export steer during summer conditions could consume 60 L of water daily; using values observed in this study, ingestion of saline levels up to 120 g/d or Na levels up to 45 g/d could occur. Ration Na contents observed in this study (maximum 0.36 % DM) could also contribute up to 40 g daily to intake of this same steer. Dietary Na is a significant factor in Na excretion in cattle (Shuyler *et al.* 1975), and results from this survey lend support to this.

Using the example of Na, theoretical intakes from both drinking water and ration would exceed dietary requirements (0.8 g/kg DM, SCA 1990) in the majority of feedlots surveyed. Waste minimisation in cattle feedlots involves reduction in both quantity and environmental impact potential of the waste (manure) generated (Tucker and Watts 1993). The results of this survey of factors affecting the salinity levels in manure have important implications for minimising waste. First, the salinity (mineral) contents of drinking water should be taken into account by nutritionists when formulating rations, with water source a significant factor in water quality. Second, ration Na levels in many feedlots appear high and consideration should be given to adjusting ration formulations to reduce Na content.

The methods and analysis employed in this survey have provided evidence for the relationships of saline inputs to saline excretion and manure levels in Australian feedlots within the range of ration types and cattle production systems considered indicative of the industry. Further, the ranges of parameter values observed provide baseline data for continued investigations into the area of waste minimisation. Future studies will critically examine animal inputs, diet digestibility and excretion factors within controlled experimental regimes, to reassess the impact of ration formulations on the environment.

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