

# HISTOLOGICAL EXAMINATION OF THE BOVINE ADRENAL GLAND AS AN INDEX OF SODIUM STATUS

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## Summary

Adrenal glands were taken from 274 cattle from nine districts in Southern inland Queensland after slaughter at a commercial abattoir. A high proportion of cattle from five districts had hyperplasia of the zona glomerulosa region of the adrenal cortex. From previous work in which hyperplasia of the zona glomerulosa was experimentally induced by feeding low sodium diets, it was considered that sodium deficiency was implicated when the ratio of the width of the zona glomerulosa and total adrenal cortex was greater than 0.2.

The use of this ratio to detect areas of low Na intake is discussed.

## I. INTRODUCTION

Murphy and Plasto (1972) reported sodium (Na) deficiency in a herd of beef cows and calves grazing native pastures in a district of Southern inland Queensland. This deficiency was attributed to the low levels of Na in pasture samples ( $<6$  m-equiv. Na/kg d.m.) and in drinking water ( $<2$  m-equiv. Na/l), and confirmed by the significant liveweight responses obtained when a Na supplement was fed (Murphy and Plasto, 1973). The pasture species involved are dominant in much of Southern Queensland and subsequent pasture analyses have indicated the possibility of Na deficiency in a number of districts.

In sodium deficient cattle there is a marked hyperplasia of the zona glomerulosa region of the adrenal cortex (Scoggins *et al.* 1970; Morris and Gartner 1971, 1975). We have determined the degree of hyperplasia in cattle sent for slaughter from nine districts in Southern Queensland and these results are discussed relative to the potential of this measurement for locating areas of low Na intake.

## II. MATERIALS AND METHODS

### (a) Experimental Procedures

Adrenal glands were collected from 228 steers and 46 cows slaughtered at an abattoir in Southern Queensland (K.R. Darling Downs, Toowoomba). The cattle sampled, were drawn from 15 consignments from nine districts. The districts and the number of animals from each, are shown in Table 1. Five consignments contained cows only; the remainder contained steers only.

Rumen samples for electrolyte analysis were obtained at slaughter from each of the 38 steers in the consignment from Toowoomba,

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### (b) Histological Measurements

Whole adrenal glands, from the left side, were removed at slaughter and placed in 10% buffered, neutral formalin. Hyperplasia was estimated as a function of the ratio of the width of the zona glomerulosa to total adrenal cortex. These measurements were determined by a modification of the technique used by Morris and Gartner (1971). Transverse blocks of preserved tissue, 3 mm thick, were cut from along the longitudinal axis at the centre of the gland. Sections, 5  $\mu$ m thick, were cut from these blocks, mounted on glass slides, and stained with modified haematoxylin and eosin to improve differentiation of the adrenal cortical zones. The slide was inserted directly into a photographic enlarger (Leitz Focomat, X15) and projected onto a grid pattern. This indicated six sites, spaced equidistantly around the periphery of the section, where the widths of the zona glomerulosa and total cortex were determined by a vernier caliper. The ratio of widths was calculated for each site and averaged to-derive a mean hyperplastic ratio for each animal.

### (c) Electrolyte analysis

Na and potassium (K) concentrations in rumen samples were determined by flame photometry. .

## III. RESULTS

TABLE1

Mean and standard error for adrenal hyperplastic ratios in cattle from nine districts and the distribution of individual animal ratios within each district

District	No. of Consignments	Adrenal hyperplastic ratio	No. of animals with ratios:		
			<0.20	0.20 to 0.30	>0.30
Toowoomba	(1)	0.128 $\pm$ 0.005	38	2	
Wandoan	(5)	0.140 0.003	96	2	
	(2)*	0.164 0.008	12	4	
Jandowae	(1)	0.121 0.010	10		
Killarney	(1)*	0.236 0.015	2	9	1
Cooyar	(1)*	0.190 0.010	8	4	
Djuan	(1)*	0.203 0.017	3	3	
Bringalilly	(1)	0.157 0.006	26	3	
Goondiwindi	(1)	0.173 0.010	16	4	
Yuleba	(1)	0.140 0.004	35	1	

\* Denotes consignments of cows only

Table 1 shows the adrenal hyperplastic ratios in cattle from each of the nine grazing districts. More than 25% of animals from the Killarney, Cooyar, Djuan and Goondiwindi districts had ratios exceeding 0.20. The highest ratio of 0.31 was from a cow from the Killarney district.

Of the seven consignments from the Wandoan district, one group of 10 cows had 40% of hyperplastic ratios greater than 0.20. The mean ratio of this group was  $0.176 \pm \text{S.E. } 0.011$ .

The mean and standard error of the Na and K concentrations of the rumen samples from the Toowoomba consignment were  $146.5 \pm 0.7$  and  $13.5 \pm 0.5 \text{ m-equiv./l}$  respectively.

#### IV. DISCUSSION

Morris and Gartner (1975) measured the extent of hyperplasia of the zona glomerulosa in steers receiving either deficient (0.4 g/d) or adequate ( $>3.1 \text{ g/d}$ ) intakes of Na for a period of 130 days. The Na deficient group, had a mean hyperplastic ratio of  $0.31 \pm 0.014$  compared with  $0.129 \pm 0.014$  in the Na adequate group.

Electrolyte levels in the rumen fluid from steers in the Toowoomba consignment indicated that they were Na replete at slaughter as judged by the rumen electrolyte data of Murphy, Morris and Gartner (1970). Further, their mean hyperplastic ratio of 0.128 was similar to that found in Na adequate steers by Morris and Gartner (1975). These comparisons clearly show that cattle from the Toowoomba consignment were Na adequate and therefore their mean hyperplastic ratio  $\pm 2$  standard deviations was taken as the interval of ratios likely to be found in Na replete cattle. The upper limit of this ratio was 0.19.

We found hyperplastic ratios greater than 0.20 in 25% of the steers from the Goondiwindi district and in more than 30% of cows from the Killarney, Cooyar and Djuan districts as well as in one of the two consignments from Wandoan. These results imply suboptimal Na intakes and are consistent with the low levels of Na ( $<6 \text{ m-equiv. Na/kg d.m.}$ ) that have been found in the dominant pasture species in certain districts of the Southern inland region (Murphy and Plasto 1973, and unpublished data).

The results also indicate that hyperplasia was more prevalent in cows than in steers. Presumably, this reflects the known higher requirement for Na during pregnancy and lactation than for growth. Smiciklas, Pohanka and Pike (1971) demonstrated that provided Na intake was adequate, pregnancy per se did not induce hyperplasia of the zona glomerulosa.

It is concluded that hyperplastic ratios can provide a useful adjunct to existing techniques for locating areas of low Na intake. The provision of Na supplements in such areas can be warranted, as demonstrated by Murphy and Plasto (1973).

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