Tropical Animal Production 1983 45-49

THE RESPONSE OF CATTLE IN THE THAI HIGHLANDS TO A SUPPLEMENT CONTAINING SODIUM AND PHOSPHORUS[1]

J Lindsay Falvey

MPW Rural Development, 187-189 Canterbury Road, Blackburn 3130, Melbourne, Australia

Two groups of cattle, one of which received a daily supplement containing Na and P, grazed native highland pasture in Thailand for a period of 39 months. Significant ($P < 0.05$) live - weight responses were recorded and differences in reproduction and calf mortality rates ampli - fied the response in terms of total productivity ($P < 0.001$). Significant differences ($P<0.05$) were observed in the salivary Na:K ratios, the rumen fluid Na and K contents and Na:K ratio and faecal Na contents, but not in terms of serum Na or K contents. No significant diferences ($P < 0.05$) were observed in rib-bone P content or specific gravity, rumen fluid or faecal P, or for other analyses such as those related to N and Ca. The productivity response was associated with the Na fraction of the supplement.

Key words: cattle, sodium (Na), phosphorus (P), liveweight change, reproduction

The principal technical constraint to development of the small cattle industry in the highlands of northern Thailand is nutrition.(Falvey 1977). The low levels of productivity commonly recorded for cattle in the region can be improved by supplementary feeding of minerals, urea and molasses (Falvey and Mikled 1978). However, specific nutrient deficiencies have yet to be identified.

Native highland pastures often show phosphorus and sodium contents below 1.8g/kg DM and 1.0g/kg DM respectively (Falvey et al 1980) and symptoms of specific mineral deficiencies, such as drinking of urine (sodium), have been observed in the region.

Cattle grazing tropical pastures have been reported to respond to phosphorus (Cohen 1975) and, in recent studies, to sodium (Leche 1977) in terms of liveweight change and reproduction. Bott et al (1964) have em - phasised the need for productivity studies that determine the effect of low sodium intake, because of the compensatory effect of potassium for sodium under such conditions.

This experiment aimed to measure the response of cattle grazing nat - ive highland pastures to a supplement containing both sodium and phosphorus, and to determine the mechanism of that response.

Materials and Methods

Location: The experiment was conducted in Chiang Mai province, Thailand (19°N 99°E) at an elevation of 1,500m. Soils of the highlands are predominantly granite based podzolics which are high in organic matter.The climate is tropical monsoonal modified by altitude with a mean annual rainfall of 1630 mm, of which 90% falls within the six months from May to October.

[1] *This research was conducted when the author was working with the Thai-Australian Highland Agricultural Project, Chiang Mai University, Chiang Mai, Thailand; a project funded by the Australian Development Assistance Bureau*

Experimental animals and pasture: Two groups of nine native yellow Asian cattle (seven cows and two steers) each grazed native pastures composed mainly of *Imperata cylindrica* each day from June 1976 to September 1979. Each night, cattle were herded into yards in keeping with the traditional practice. Cattle were weighed every 28 days.

Supplement: Cattle in one group received a daily drench of an aqueous solution of NaH_2PO_4 at the rate of 30g/head/d. Cattle in the other group did not receive any supplement.

Collection of samples: Faecal samples were collected from the rectum (ten samplings), blood was collected from the tail vien (five samplings) and serum separated from the clot. Saliva was collected under suction from the mouth (three samplings), rumen fluid was collected (once) by insertion of a plastic tube via the mouth, and rib bone samples were collected from the 11th rib (once) by the method described by Little(1972).

Analysis of samples: Oven dried (100°C) faeces were analysed for N, P and Na while serum, saliva and rumen fluid supernatant were analysed for Na, K, P and Ca. Bone samples were analysed for P and specific gravity.

Results

Faecal analyses: The mean faecal N, P and Na analyses for both groups are presented in Table 1. There were no significant differences ($P > 0.05$) in the N or P contents in the faeces of the two groups. Faecal Na values were significantly higher ($P < 0.05$) for those cattle receiving the supplement at each of the seven sampling dates.

Serum analyses: There were no significant differences ($P > 0.05$) between the treatment groups for any of the serum analyses, although the inorganic phosphate contents of the supplemented cattle tended to be lower and the Na content higher, than those from the unsupplemented cattle.

Saliva and rumen fluid analyses: Mean values for the contents of Na, K, Ca and P in saliva and rumen fluid are presented in Table 2. There were no significant differences ($P > 0.05$) between the supplemented and unsupplemented cattle in salivary phosphorus, calcium and urea, or in rumen fluid phosphorus, calcium and ammonia. There were, however, significant differences between the two groups in salivary sodium: potassium ratios ($P < 0.01$). The percentage of phosphorus in rib-bone, the percentage of phosphorus in the bone after refluxing, the concentration of phosphorus in the bone (mg/ml) and the specific gravity of the bone were 7.30, 13.07, 118.8 and 1.625 for the supplemented group and 7.96, 14.91, 131.4 and 1.651 for the unsupplemented group, respectively; there were no significant ($P > 0.05$) differences between the two groups for any of these parameters.

Liveweight changes and reproduction: Liveweight and reproductive data for both groups are presented in Table 3. Liveweight gains of the cattle receiving the phosphorus drench were significantly higher ($P<0.05$) over the late dry and wet seasons in 1977, the late dry-early wet season of 1978 and the whole period of the experiment. There were no significant differences between the supplemented and unsupplemented groups in

Table 1:

Mean faecal N, P and Na analyses (g/kg DM) for supplemented and unsupplemented cattle

Treatment	3/3/77			21/7/77			1/3/78			4/5/78			24/5/78		
	N	P		N	P		N	P	Na	N	P		N	P	Na
Supplemented	26.8	4.6		17.2	3.8		7.8	4.3	1.1**	18.3	6.2		22.5	6.8	1.9**
Unsupplemented	14.1	5.0		18.2	4.6		7.7	5.2	0.6	19.7	6.4		24.8	7.3	0.6

Treatment	16/8/78			10/10/78			14/2/79			24/5/79			24/8/79		
	N	P	Na	N	P	Na	N	P	Na	N	P	Na	N	P	Na
Supplemented	16.3	5.9	1.3**	15.7	4.4	1.4**	12.3	6.3	3.4**	15.2	5.1	0.8*	6.8	5.4	3.5*
Unsupplemented	17.9	5.2	0.7	18.2	4.1	0.6	14.5	5.9	0.7	17.3	5.4	0.4	6.7	4.9	1.2

Significant differences between means at any one date are signified by *($P<0.05$) and ** ($P<0.01$).

Table 2:
Mean saliva and rumen fluid contents of Na, K, Ca, P and Na:K ratios of supplemented and unsupplemented cattle

Analysis	Saliva 14/2/79		Saliva 30/4/79		Saliva 24/8/79		Rumen fluid 30/4/79	
	Supplemented	Unsupplemented	Supplemented	Unsupplemented	Supplemented	Unsupplemented	Supplemented	Unsupplemented
Na (meq l^{-1})	132.4**	101.6	116.7	101.5	103.2	85.4	92.7*	77.8
K (meq l^{-1})	8.6**	15.4	22.4*	42.3	17.0	38.7	12.2*	20.6
Ca (mg %)	2.2	2.6	1.5	1.5	3.7	3.8	3.2	3.0
P (mg %)	44.9	60.4	34.7	46.3	37.2	54.1	55.4	55.9
Na:K	15.4**	6.6	8.2**	2.7	7.7*	3.3	9.0**	4.5

Significant differences between means within a sampling date are signified by *($P<0.05$) and ** ($P<0.01$).

Table 3:
Liveweights and reproductive data for supplemented and unsupplemented cattle

	Liveweight								
	Initial	Early wet	Late dry	Early wet	Late dry	Final	No of calves	No of calves conceived	Mortality rate calves(%)
	28/6/77	3/3/77	2/1/78	26/4/78	3/1/79	16/8/79			
Supplemented	168.3	176.1	193.8	202.9	220.2	251.0	19	112	15.8
Unsupplemented	171.8	160.8	167.2	172.0	202.1	246.8	12	7	41.4

terms of the total number of calves born during the experiment and the total number of calves conceived during the experiment. However, mortality rates of calves were significantly lower for the supplemented group.

Discussion

Phosphorus: Cohen (1975) has noted the absence of salivary P data although he has recorded concentrations in rumen fluid of 15.0 to 18.5 mg/100 ml under P deficient conditions, which are much lower than the mean concentration of about 55 mg P/100 ml recorded in this study.

Rib bone samples are possibly the most accurate indicator of the P status of ruminants. Little and Minson (1977) recorded a mean P content of 11.66% in dry fat free bone (cf 13.0% and 14.91% in this study) for cattle that had grazed pastures fertilised with P. Other figures are not comparable due to differing fat contents in bone. The lack of any difference between groups, even when only non-lactating cows were considered, indicates that additional dietary P was of little consequence.

Sodium: In instances of Na deficiency, increased intestinal absorption of Na and consequent reduced faecal Na occurs while plasma Na levels vary only slightly and salivary Na is replaced by K (Denton 1956). Thus the absence of variation between the serum Na and K levels of the two groups in this experiment is not at variance with the significant differences in salivary Na:K ratios of 8 to 30:1 for Na sufficient and 0.3 – 5.1 for Na deficient cattle,which is consistent with the results of this experiment. It is also of interest to note that the salivary Na level of unsupplemented cattle approached , or were below,the suggested minimum level of 100 mg/L (Alexander 1973).

Animal productivity: Responses occurred during the wet season when cattle can gain liveweight as a result of the higher digestible energy and protein intake, and it is under those conditions that mineral deficiencies may limit growth rate. To compare the effect of supplementation on total productivity, the liveweight gain of cows and steers plus the liveweights of calves at 250 days of age including those calves conceived before but born during the experimental period , (five in each group), and omitting calves that died before weaning, were calculated; the difference between the groups was significant at $P < 0.001$.

The response recorded in this study can be attributed to the Na rather than to the P component of the supplement, a result similar to that of studies conducted in Australia (Murphy and Plasto 1972). While this may not be the only mineral deficiency of cattle in the Thai highlands, it is probably the easiest one to remedy by feeding salt to cattle when they return from grazing each day.

References

Alexander G I 1973 Manual of Techniques for Field Investigations with Beef Cattle CSIRO Canbarra

Bott E, Denton D A, Goding J R & Sabine J R 1964 Sodium deficiency and corticosteroid secretion in cattle Nature 202:461

Cohen R D H 1975 Phosphorus for grazing beef cattle Australian Meat Research Committee Review 26:1

Denton D A 1956 The effect of Na depletion on Na:K ratios of the parotid saliva of sheep Physiology 131:516

Falvey J L 1977 Ruminants in the Highlands of Northern Thailand An Agrosociological study Australian Development Assistance Bureau Canberra 124pp

Falvey J L & Mikled C 1978 Dry season supplementation of cattle in Northern Thailand Proceedings of the Australian Society of Animal Production 12:175

Falvey J L, Hengmichai P & Pongiachan P 1980 The productivity and nutritive value of *Imperata cylindrica* in the Thai Highlands Journal of Range Management 34:280

Leche T P 1977 Effects of sodium supplement on lactating cows and their calves on tropical native pastures Papua New Guinea Agricultural Journal 18:11

Little D A 1972 Bone biopsy in cattle and sheep for studies of phosphorus Australian Veterinary Journal 48:688

Little D A & Minson D J 1977 Variations in the phosphorus content of bone samples from the last three ribs of cattle Research in Veterinary Science 23:394

Murphy G M & Plasto A W 1972 Sodium deficiency in a beef cattle herd Australian Veterinary Journal 48:129

Received 1 October 1982