Proc. Aust. Soc. Anim. Prod. Vol. 19

COBALT AND VITAMIN B_{12} SUPPLEMENTATION OF YOUNG SHEEP

G. J. JUDSON, R. K. TURNBULL and B. R. KEMPE

South Australian Dept of Agriculture, Box 1671 GPO Adelaide, S.A. 5001.

SUMMARY

The efficacy of 4 treatments in maintaining adequate plasma and liver vitamin B_{12} concentrations was compared in young sheep grazing a cobalt (Co)-deficient site in the south east of South Australia. The treatments were injections of B_{12} or an intraruminal glass pellet containing Co prior to weaning and at weaning intraruminal glass pellets or Co pellets. A liveweight and fleece weight response was obtained to treatment. The intraruminal pellets maintained normal B_{12} status of sheep grazing Co-deficient pasture for about 1 year.

Keywords: sheep, vitamin B_{12}, cobalt supplements, fleece weight, liveweight.

INTRODUCTION

In South Australia, cobalt deficiency in sheep is widespread although severe Co deficiency is usually restricted to the coastal regions (Reuter *et al.* 1988). The Co is required for the synthesis of B_{12} by the ruminal micro-organisms and it is the vitamin that is required by the host tissues. However, in animals grazing phalaris a continuous supply of Co in the rumen is desirable since the prevention of phalaris staggers seems to reflect an independent role of Co in ruminal detoxification.

For the prevention of Co deficiency in sheep it is generally recommended that subcutaneous injections of B_{12} be administered to lambs, commencing at tail docking and castration (marking), and Co intraruminal pellets at weaning for long-term protection (Reuter *et al.* 1988). The development of soluble glass pellets containing Co offers an alternative method of preventing Co deficiency in sucking and weaner sheep (Knott *et al.* 1985). In this study these various supplements were tested for their effectiveness in providing B_{12} to young sheep grazing a Co deficient pasture.

MATERIALS AND METHODS

An experiment was undertaken on ground-water rendzina soils near Naracoorte, South Australia. On 26 July 1984, Merino lambs at marking (week 0 of the experiment) were blocked within sex into groups of similar liveweight. From each block, lambs were allocated to 5 treatment groups, each of 7 wethers and 7 ewes, namely: Control – no B_{12} or Co treatment; B 12/CoP – 2 mg B_{12} subcutaneously at week 0 and a 10 g Co pellet at weaning (week 11); B 12/GlP – 2 mg B_{12} at week 0 and a 34 g glass pellet at weaning; LGlP/GlP – a 17 g glass pellet at week 0 and a 34 g glass pellet at weaning, and LGlP – a 17 g glass pellet at week 0. The Co pellet which contained 30% by weight Co_3O_4 (Formula E, Top Australia Ltd) was given orally with 2 steel grinders. The soluble glass pellets (Cosecure, Chance Pilkington Ltd) contained by weight 13.4% copper (Cu), 0.3% selenium (Se) and 0.5% Co.

The lambs were run as 1 mob until the experiment was terminated at week 67 when sheep were shorn. Sheep were weighed at frequent intervals (Table 1). At each weighing, blood samples for B_{12}, Se and Cu assay were collected from 4 wethers and 4 ewes from each treatment group into heparinised containers: liver biopsies for B_{12} assay were also obtained from these sheep at weeks 11, 25, 38, 50 and 66. Vitamin B_{12} assays were as described by Judson *et al.* (1988).

The liveweight and B_{12} results were subjected to a split-plot analysis of repeat measures with the main plot stratum being sex x sheep x treatment and the subplot stratum being sex x sheep x treatment x time. The plot of residuals against fitted values revealed heterogeneity for plasma B_{12} values. A $\log_{10}$ transformation was therefore performed and the analyses repeated. Vitamin B_{12} concentrations given in Table 1 are arithmetic means. Fleece weights were tested by 2-way analysis of variance using sheep as the block. Difference between treatment means was tested using the least significant difference test.

RESULTS

Table 1 gives the mean liveweights and plasma B_{12} concentrations for each treatment group. Significant ($P < 0.001$) treatment x time and sex x time interactions were observed for liveweight. An increase to treatment was observed at weeks 25, 59 and 66. At week 66, mean liveweights for the B 12/CoP and B 12/GlP groups were similar and greater than those of the LGlP/GlP and LGlP groups: these latter groups were similar and greater than the mean liveweight of the Control group (Table 1). The mean liveweight of wethers (45 kg) was significantly greater ($P < 0.05$) *than ewes* (41 kg) at week 66. Treatment had a significant effect ($P < 0.01$) on fleece weight of sheep. The mean fleece plus belly

Table 1. Liveweight (kg) and plasma vitamin B_{12} concentrations (pmol/L) in sheep given different cobalt and vitamin B_{12} supplements (B12/CoP, B_{12} at mating + Co pellet at weaning; B12/GlP, at marking + glass Co pellet at weaning; LGlP/GlP, glass Co pellet at marking and again at weaning; LGlP, glass Co pellet at weaning)

Mean values are for 14 sheep (liveweight) and 8 sheep (vitamin B_{12}). Means followed by the same letter within each column are not significantly different at $P = 0.05$

Treatment	Week of experiment: 0	5	11	19	25	31	38	44	50	59	66
					Liveweight						
Control	14.7a	18.4a	23.5a	26.8a	32.5a	34.6a	32.1a	32.1a	32.2a	37.1a	39.3a
B12/CoP	14.6a	20.3a	25.3a	28.7a	35.0b	36.6a	33.4a	33.1a	33.2a	40.2bc	45.4c
B12/GlP	14.7a	20.1a	24.5a	28.5a	34.7b	36.4a	33.2a	33.3a	33.4a	41.8c	45.8c
LGlP/GlP	14.6a	20.3a	24.9a	27.5a	33.4ab	35.3a	31.9a	31.9a	31.9a	38.5ab	42.6b
LGlP	14.5a	19.9a	24.5a	27.7a	33.9ab	35.7a	32.2a	32.1a	32.1a	39.4b	42.9b
					Plasma vitamin B_{12}						
Control	178a	120a	311a	348a	403a	313a	374a	237a	126a	149a	92a
B12/CoP	318b	279b	385a	764b	1085bc	825b	765b	840b	298b	571b	333d
B12/GlP	245ab	159ab	320a	1169bc	1216bc	1229b	1921c	852b	751c	459b	267cd
LGlP/GlP	234ab	815c	874b	1790c	1816c	1353b	1777c	942b	640c	543b	233bc
LGlP	321ab	746c	850b	871b	1149b	945b	1226bc	864b	534c	338b	129ab

weight (kg) for the Control, B 12/CoP, B 12/GlP, LGlP/GlP and LGlP treatment groups were respectively 3.8, 4.1, 4.4, 4.2 and 4.1 (s.e.d. = 0.18).

A significant ($P < 0.001$) treatment *x* time interaction was observed for plasma B_{12}. The lamb glass pellets increased the mean values at week 5 and this increase was maintained at week 11 (weaning). There was no clear indication of a raised mean plasma B_{12} concentration at weeks 5 and 11 in response to the B_{12} injection (Table 1). From week 11 the mean plasma B_{12} values were raised above the corresponding values for the Control group at all stages of the experiment for the B 12/CoP, B 12/GlP and LGlP/GlP groups and up until week 59 for the LGlP group.

A significant ($P < 0.05$) sex *x* treatment *x* time interaction was observed for liver B_{12} concentrations. Table 2 gives the mean values for each sex within each treatment group. Significant increases in the mean liver B_{12} concentrations were usually observed at weeks 25, 38 and 50. Except for the LGlP group there was no consistent difference between sex within treatment. In the LGlP group mean liver B_{12} concentrations were greater ($P < 0.05$) in ewes than in wethers at weeks 25 and 50.

Mean plasma Cu and blood Se concentrations for each of the treatment groups were greater than 8 μmol/L and 0.5 μmol/L respectively at all samplings indicating that the sheep were not at risk of Cu or Se deficiency during the experiment (Judson *et al.* 1987).

Table 2, Liver vitamin B_{12} concentrations (nmol/kg wet weight) of sheep given different cobalt and vitamin B_{12} supplements (B12/CoP, B_{12} at mating + Co pellet at weaning; B12/GlP, at marking + glass Co pellet at weaning; LGlP/GlP, glass Co pellet at marking and again at weaning; LGIP, glass Co pellet at weaning)

Mean values of 4 sheep

For each column, means followed by the same letter are not significantly different at $P = 0.05$

Treatment	Sex	Week of experiment: 11	25	38	50	66
Control	Wether	51a	90a	125a	123a	43a
	Ewe	57a	80a	195ab	125a	43a
B12/CoP	Wether	125a	489d	347bc	467cd	203ab
	Ewe	151a	236ab	470cd	316bc	232b
B12/GlP	Wether	72a	417bcd	460cd	285abc	210ab
	Ewe	109a	345bcd	470cd	466cd	181ab
LGlP/GlP	Wether	128a	457cd	385cd	327bcd	93ab
	Ewe	184a	347bcd	324bc	510d	162ab
LGlP	Wether	126a	284bc	441cd	244ab	94ab
	Ewe	143a	476d	558d	452cd	178ab

DISCUSSION

In this study the mean B_{12} concentrations in plasma and liver of sheep in the Control group indicate that Co intake was inadequate at most stages of the experiment, particularly during late winter to spring (weeks O-l 1 and 50–66). Mean values indicative of normal B_{12} status in sheep are greater than 400 pmol/L plasma and 200 nmol/kg fresh liver (Judson *et al.* 1987). The low B_{12} status of the Control group was associated with depressed growth rate and probably depressed wool production. Shallow *et al.* (1989) reported that wether lambs were more susceptible than ewe lambs to Co deficiency. There was no evidence in the present study of a sex effect in response of liveweight to Co although liver B_{12} concentrations differed between sex within treatment groups at times during the experiment (Table 2).

The 17 g glass pellet maintained normal B_{12} status of sheep for almost 1 year and the additional treatment of a 34 g glass pellet at weaning had only a marginal benefit in maintaining normal B_{12} status of sheep. This and other studies (see Judson *et al.* 1988) indicate that the soluble glass pellet is an alternative treatment for providing Co to sheep. However, these pellets are not available on the Australian market and there have been problems with the commercial production of these pellets in Great Britain (Judson *et al.* 1988).

A suggested treatment regime for sheep retained on Co deficient pasture is to administer B_{12} injection at marking and an intraruminal Co pellet at weaning. The lack of a response in plasma B_{12} concentrations 5 weeks after an injection of B_{12} to lambs (see Table 1) is consistent with other studies indicating that plasma B_{12} concentrations were unreliable as indicators of B_{12} status in sheep given such injections (Judson *et al.* 1989). Dewey *et al.* (1969) showed that 1 Co pellet with or without a steel grinder or 2 Co pellets in the rumen were effective in maintaining adequate B_{12} status for more than 5 years in penned sheep given a Co deficient diet. In those studies the pellet contained 60% by weight Co_3O_4. In the late 1970's the Co_3O_4 content of the commercially available pellets was reduced to 30%. The present study indicates that 1 of these pellets was effective in maintaining normal liver B_{12} reserves for the period of the experiment (55 weeks after dosing) but not normal plasma B_{12} concentrations. As plasma B_{12} concentrations in sheep are more responsive than liver B_{12} to current intake of Co (Sutherland 1980) this suggests that Co availability was marginal towards the end of the experiment (see Table 1). Millar and Albyt (1984) reported that the Co pellet, containing 30% by weight Co_3O_4, maintained raised serum and liver B_{12} concentrations in sheep for only about 14 weeks whereas Masters and Peter (1990) showed that the pellet was effective for at least 54 weeks in maintaining raised plasma B_{12} concentrations. These differences in the effective life of the Co pellet may be due in part to different brands or batches of the pellet.

Further studies are needed to determine the effective life of the current Co pellet. The present findings suggest that a Co pellet may have to be given annually to maintain normal B_{12} status of sheep grazing Co deficient pasture.

ACKNOWLEDGMENTS

The skilled technical assistance of Ms W. J. Babidge, Ms R. Coventry and Ms J. Kelly are greatly appreciated. This work was supported by a grant from the Australian Meat and Livestock Research and Development Corporation. We thank Mr P. Hood, Bool Lagoon for his co-operation in providing sheep and facilities.

REFERENCES

DEWEY, D. W., LEE, H. J. and MARSTON, H. R. (1969). *Aust. J. Agric. Res. 20:* 1109-16.

JUDSON, G. J., BROWN, T. H., KEMPE, B. R. and TURNBULL, R. K. (1988). *Aust. J. Exp. Agric.* **28:** 299–305.

JUDSON, G. J., CAPLE, I. W., LANGLANDS, J. P. and PETER, D. W. (1987). *In* 'Temperate Pastures: their Production, Use and Management.' (Eds J. L. Wheeler, C. J. Pearson and G. E. Robards.) pp. 377–85. (Australian Wool Corporation-CSIRO:Melboume.)

JUDSON, G. J., SHALLOW, M. and ELLIS, N. J. S. (1989). *In* 'Trace Elements in New Zealand: Environmental, Human and Animals' (Eds R. G. McLaren, R. J. Haynes and G. P. Savage.) pp. 225-9. (Lincoln College Printer-y: Lincoln Canterbury.)

KNOTT, P., ALGAR, B., ZERVAS, G. and TELFER, S. B. (1985). *In* 'Trace Elements in Man and Animals - TEMA 5' (Eds C. F. Mills, I. Bremner and J. K. Chesters.) pp. 708-13 (Cwealth. Agric. Bur.: Slough).

MASTERS, D. G. and PETER, D. W. (1990). *Aust. J. Exp. Agric. 30:* 337–41.

MILLAR, K. R. and ALBYT, A. T. (1984). *N. Z. Vet. J. 32:* 105–8.

REUTER, D. J., CARTWRIGHT, B., JUDSON, G. J., McFARLANE, J. D., MASCHMEDT, D. J. and ROBINSON, J. B. (1988). Technical Report No. 139, Depart. Agriculture, South Australia.

SHALLOW, M., ELLIS, N. J. S. and JUDSON, G. J. (1989). *Aust. Vet. J. 66:* 250–1.

SUTHERLAND, R. J. (1980). *N. Z. Vet. J. 28:* 169-70.