

COBALT SUPPLEMENTATION OF WHOLE WHEAT DIETS FOR WEANER LAMBS

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SUMMARY

The effect of cobalt supplementation of wheat and wheat-based diets on the liveweight gain and fatty acid composition of adipose tissue of lambs was investigated. Cobalt had little effect on the proportion of odd carbon number and branched chain fatty acids in adipose tissue. In lambs which had previous access to pasture, Co supplementation of whole wheat (0.35 mg/kg Co compared with 0.08 mg/kg Co) had no effect on liveweight gain, but in lambs weaned onto whole wheat, Co supplementation resulted in 22% greater liveweight gain. Dietary Co supplementation of lambs weaned onto 70% wheat/30% hammermilled lucerne hay was ineffective.

INTRODUCTION

Lambs eating diets based on high proportions of cereal grains develop soft, oily carcass fat which is characterized by an increased proportion of triglyceride fatty acids with odd carbon numbers and branched chains. These have a lower melting point than the saturated acids they replace (Duncan *et al.* 1972). Of the cereal grains, wheat gives rise to the greatest increase in proportion of odd and branched chain fatty acids in adipose tissue triglycerides (Duncan *et al.* 1974a) and is associated with marked 'off odour' on cooking (Oddy and Saville, unpublished observations).

The occurrence of these fatty acids is due to propionate incorporation during fatty acid synthesis, either as propionyl CoA the precursor for odd chain number acids, or methylmalonyl CoA a precursor of branched chain acids (Garton 1975). Metabolism of methylmalonyl CoA involves the cobalt-containing vitamin B₁₂ as a co-factor and both propionate and methylmalonate accumulate in vitamin B₁₂ deficiency. Vitamin B₁₂ is synthesised in the rumen from cobalt (Co), and the rate of synthesis is lower on high concentrate diets than on roughage diets (Sutton and Elliott 1972).

If the occurrence of odd and/or branched chain fatty acids in the fat of lambs eating wheat grain diets was due to vitamin B₁₂ deficiency then it may be possible to correct the objectionable aspect of soft fat and cooking odours and also to increase liveweight gain by Co supplementation. This report outlines two experiments which investigated the effect of additional dietary Co on the performance and fatty acid composition of adipose tissue of lambs eating wheat diets. In the first lambs had prior access to good pasture, and in the second the effect of early weaning of drought-affected lambs directly onto diets of wheat or wheat and lucerne hay was investigated.

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MATERIALS AND METHODS

Experiment 1.

Twenty eight Border Leicester x Merino wether lambs, 8-10 months old and of mean weight 20 kg, were taken from pasture and placed in individual pens in an animal house. After introduction to a diet of wheat grain they were allocated to one of two groups. One group had *ad libitum* access to wheat which was sprayed with 250 mg Co, as $\text{Co Cl}_2 \cdot 6\text{H}_2\text{O}$ in 5 L water, per tonne of wheat, and the other group were offered untreated wheat *ad libitum*. Each diet was supplemented with 1.3% NaCl and 1.5% CaCO_3 and contained 0.35 mg/kg and 0.08 mg/kg Co respectively on a dry matter basis.

Feed intakes were recorded every second day and the lambs were weighed every second week. At the completion of the experiment, when the lambs were 35 kg, a sample of jugular blood was obtained and subcutaneous fat was taken from above the tail.

Experiment 2.

One hundred and fifty-one Merino lambs 7 weeks old were weaned onto a diet of either wheat grain or wheat grain/hammermilled lucerne hay (70/30). They were allocated to 8 groups of 18 or 19 lambs of similar mean weaning weight and held in bare earthen yards 12 x 18 m. The diets were wheat or 70/30, either treated with 250 mg cobalt/tonne or untreated and were offered *ad libitum* to 2 groups of lambs for each diet.

Feed intake was recorded weekly and all lambs were weighed fortnightly. After 12 weeks the lambs were slaughtered and samples of peri-renal adipose tissue collected.

Analytical

The proportion of fatty acids in the adipose tissue triglycerides was determined by gas-liquid chromatography of their methyl esters on both ethylene glycol adipate and Apiezon L liquid phase columns. Plasma acetate and propionate concentrations were determined on steam distillates by gas-solid chromatography using a Chromasorb 101 column. Neutron activation analysis was used to determine Co concentration in the wheat grain used in experiment 1.

Experiment 1 was analysed by one way analysis of variance. Experiment 2 was analysed as a 2x2 factorial for diet type and Co level.

RESULTS

Experiment 1.

The addition of Co to the wheat grain diet did not cause the lambs to increase liveweight gain or feed intake. Mean liveweight gains were 151 and 158 (S.E.+11.4) g/day and daily feed intakes 74.4 and 78.0 (S.E.+3) g/kg $\text{LW}^{0.75}$ on untreated and treated wheat respectively.

There were some differences due to Co supplementation in the proportions of fatty acids in subcutaneous fat. The proportion of 17:0 was reduced from 5.52 to 4.18 (S.E.+0.47) g/100g ($P<0.05$), there was an increase in the proportion of the unsaturated acids 16:1, 18:1, 18:2, 18:3 from 44.4 to 47.6 (S.E.+0.9) g/100g

by Co addition ($P < 0.05$), but there was no difference in the proportions of saturated or branched chain fatty acids. Neither plasma acetate nor propionate concentrations were altered by Co addition; acetate was 0.73 and 0.60 (S.E. ± 0.09) mM and propionate 41.1 and 24.2 (S.E. ± 8) μ M on control and treated diets respectively.

Experiment 2.

The effects of diet and Co on liveweight gain of lambs are shown in Table 1. There was a significant effect of diet type ($P < 0.01$), but no overall treatment effect due to Co. However, Co increased liveweight gain of lambs on wheat alone ($P < 0.05$) but not on 70/30. Mean intake of the 70/30 diet was significantly greater than that of the wheat diet, 602 vs 500 (S.E. ± 12) g/day ($P < 0.01$), and Co treatment had no significant effect on intake.

TABLE 1 Effect of diet and supplementation with cobalt on live-weight gain in lambs (g/d)

	Cobalt		Mean	
	With	Without		
Wheat	91.9	74.2	80.8	$P < 0.01$
70/30	110.3	118.6	114.4	
Mean	100.6	95.5		
	NS			

Diet type significantly affected the fatty acid composition of perirenal adipose tissue but Co was found to have no significant effect (Table 2).

TABLE 2 Effect of diet (wheat or 70%wheat/30% hammermilled lucerne hay) and Co (untreated, or 250 mg Co/tonne) on proportion of fatty acids (g/100g) in the triglycerides of perirenal fat of weaner lambs

Diet		Fatty Acid						
		14:0	16:0	18:0	18:1	18:2	Odd Chain No	Branched Chain
Wheat	-Co	1.5	17.9	31.2	34.8	2.3	6.5	3.7
	+Co	1.6	17.8	28.8	36.4	2.7	6.9	3.7
70/30	-Co	2.2	20.5	28.7	36.8	2.7	4.5	2.7
	+Co	2.3	20.9	29.6	36.5	2.8	3.6	2.5
Significance of effect of								
Diet		$P < 0.01$	$P < 0.01$	NS	NS	NS	$P < 0.01$	$P < 0.01$
Co		NS	NS	NS	NS	NS	NS	NS

DISCUSSION

The negligible effect of Co on fatty acid composition of lambs eating wheat diets reported here, together with the lack of effect of Co or vitamin B₁₂ on lambs eating barley diets (Duncan *et al.* 1974b), indicate that 'fatty acid composition is related to the high levels of propionate produced in the rumen on these diets rather than a vitamin B₁₂ deficiency. The effect of lucerne hay in the ration is to reduce the proportion of odd chain and branched chain fatty acids by lowering ruminal propionate concentration relative to that produced by similar sheep consuming a wheat diet.

The failure of Co to affect liveweight gain in lambs with prior access to pasture is probably due to the lambs having adequate tissue vitamin B₁₂ stores, and the relatively short duration of the experiment compared with the 7 to 12 weeks required to deplete tissues of vitamin B₁₂ on Co-deficient diets (Smith and Marston 1970). The critical time for Co deficiency to develop is at weaning when the reserves of vitamin B₁₂ originally obtained from the mother are depleted, and the microbial activity in the rumen necessary to convert Co to vitamin B₁₂ is developing (O'Halleran and Skerman 1961). That Co could increase liveweight gain of lambs weaned onto wheat, but not of those weaned onto 70/30, indicates reduced vitamin B₁₂ synthesis on the all wheat, compared with the 70/30 diet. Sutton and Elliott (1972) observed reduced Vitamin B₁₂ production with increasing proportion of concentrate in the diet at similar Co intakes; and at similar amounts of feed intake, Smith and Marston (1970) have shown increased vitamin B₁₂ synthesis in response to additional Co in the diet. These observations together with the results obtained here, would indicate that an amount of dietary Co which results in sufficient vitamin B₁₂ synthesis on 70/30, may be inadequate for an all wheat diet.

It is concluded that the occurrence of soft carcass fats found in lambs eating wheat diets cannot be eliminated by Co supplementation but there may be a need for dietary Co supplementation if lambs are to be weaned directly onto wheat diets with no access to roughage.

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REFERENCES

- DUNCAN, W.R. & ØRSKOV, E.R., and GARTON, G.A. (1972). *Proc. Nutr. Soc.* **31** : 19A
 DUNCAN, W.R.H., ØRSKOV, E.R., and GARTON, G.A. (1974). *Proc. Nutr. Soc.* **33** : 81A
 DUNCAN, W.R.H., ØRSKOV, E.R., FRASER, C. and GARTON, G.A. (1974b).
 Br. J. Nutr. **32** : 71
 GARTON, G.A. (1975). *Rowett Research Inst.* **31** : 124
 O'HALLERAN, M.W. and SKERMAN, K.D. (1961). *Br. J. Nutr.* **15** : 99
 SMITH, R.M. and MARSTON, H.R. (1970). *Br. J. Nutr.* **24** : 857
 SUTTON, A.L. and ELLIOTT, J.M. (1972). *J. Nutr.* **102** : 1341