SELENIUM AND VITAMIN E FOR LAMBS WITH TRICHOSTRONGYLOSIS

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SUMMARY

Thirty-two 5-month-old Merino lambs were used to study the effects of trichostrongylosis on the utilization of a dystrophogenic diet after supplementation with vitamin E and selenium in a $2 \times 2$ factorial experiment. Lambs were infected with 50,000 *Trichostrongylus colubriformis* larvae and received vitamin E (300 mg $\alpha$-Tocopherol) and selenium (3 mg Se) per os every 14 days.

Depressed feed intake per kg $^{0.75}$ (P<.05), body weight changes (P<.01) and digestibilities of dry matter and nitrogen (P<.05) were noted in infected lambs. No significant differences in performance or feed utilization were observed in the supplemented vs non-supplemented groups. Phosphorus and calcium metabolism were adversely affected by infection with the nematode. The absorption of both minerals was depressed (P<.001) and was associated with hypophosphoremia and normocalcemia.

These results show that neither intake nor digestibility was significantly improved in either infected or non-infected lambs fed a dystrophogenic diet following supplementation with selenium and vitamin E.

(Key Words: Trichostrongylosis, Nutritional Muscular Dystrophy, Selenium, Vitamin E, Lambs.)

INTRODUCTION

Nutritional muscular dystrophy (NMD) and trichostrongylosis are major problems encountered during the early growth of sheep in many areas of the world. Outbreaks of NMD are generally associated with low levels of selenium in the feed (Oksanen, 1967), and heavy nematode burdens are often the result of high animal densities (Taylor, 1930). The development of both diseases may be exacerbated under intensive grazing systems, when high stocking rates are imposed on heavily fertilized, irrigated pastures (Gardiner, 1969) or during periods of drought when sheep are held in small camps and fed forages grown under irrigation on soils known to contain marginal levels of selenium.

The synergism between selenium and vitamin E is well documented (Underwood, 1971), and though their exact roles have not been clearly defined, current opinion holds that these two factors have closely allied, yet distinct biochemical roles in metabolism (Hoekstra, 1974). Recent evidence has shown that selenium is specifically needed for the activity of glutathione peroxidase and that the enzyme contains 4 moles selenium per mole of enzyme (Hoekstra et al., 1973).

The principal manifestations of trichostrongylosis are reduced voluntary food consumption and depressed growth rate (Fitzsimmons, 1968). The efficiency of feed utilization is depressed, and while the effect of nematode infection on the digestibility of diets has not been defined conclusively (Symons, 1969), the retention of calcium (Barger, 1973) and of phosphorus (Reveron et al., 1974) may be depressed. Furthermore, both hypocalcemia (Horak et al., 1968) and hypophosphoremia (Reveron et al., 1974) have been reported in sheep suffering from acute trichostrongylosis.

The effects of selenium deficiency in cattle and sheep include NMD and reduced growth rates in young animals (Ewan et al., 1968; Paulson et al., 1968). Very little attention, however, has been given to stressing factors which may precipitate the disease, such as...
verminosis superimposed on dystrophic diets. The object of this study was to investigate the influence of induced trichostrongylosis on the performance of lambs prone to the development of NMD, and to observe the effects of treatment with vitamin E and selenium.

**EXPERIMENTAL PROCEDURE**

Thirty-two worm-free 5-month-old Merino lambs with an average body weight of 14.3 kg were utilized. The lambs were reared on the Merck, Sharpe and Dohme Research Centre near Johannesburg, where NMD had been diagnosed (Horton et al., 1977) and maintained on a ration of chopped alfalfa hay (CP, 11.6%; CF, 38.4%; Ca, 1.04%; P, 0.21%; Se, 0.04 ppm; α-Tocopherol, 26.4 mg/kg) obtained from the Vaal Hartz area which is known to be deficient in selenium.

A single 2 × 2 factorial design was used to examine the effects of trichostrongylosis and supplementation with vitamin E plus selenium on feed utilization and calcium and phosphorus metabolism. Vitamin E (300 mg α-Tocopherol) and selenium (3 mg Se as Na₂SeO₃·5H₂O) were administered as an oral drench every 14 days throughout the 98-day duration of the experiment. Infection was established by oral drenching with 50,000 larvae of *T. colubriformis*, obtained from the feces of donor sheep infected with a pure culture of the nematode. Fecal worm egg counts were carried out as described by Reinecke and Rossiter (1962) 0, 3, 5, 9 and 13 weeks after infection.

Daily feed intake and the apparent digestibility of dry matter (DM), nitrogen, calcium and phosphorus were measured 0, 5, 9 and 13 weeks after infection when the lambs were held in metabolism cages for 14-day periods. Total fecal collections were made during the last 7 days of each period and representative samples of feed and feces were retained for analyses by standard procedures (A.O.A.C., 1970). Selenium was determined by the method of Olsen et al. (1975) and vitamin E as described by Hashim and Schuttling (1966).

Venous blood samples were withdrawn from the jugular vein using vacuum tubes (Venoject, Comopharm) with heparin as anti-coagulant. Samples were taken from all lambs prior to in-

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**TABLE 1. MEAN FECAL WORM EGG COUNTS, DAILY INTAKES, APPARENT DIGESTIBILITY, AND BODY WEIGHT CHANGES IN LAMBS INFECTED WITH T. COLUBRIFORMIS AND HELD ON A DYSTROPHIC DIET AFTER TREATMENT WITH SELENIUM PLUS VITAMIN E**

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SE</th>
<th>SD</th>
<th>d-f</th>
<th>c-d</th>
<th>c-e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>11.9</td>
<td>7.5</td>
<td>21.3</td>
<td>24c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry matter intake (g/kg)</td>
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<td>6.5</td>
<td>24c</td>
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<tr>
<td>Dry matter digestibility (%)</td>
<td>68.3</td>
<td>8.2</td>
<td>24c</td>
<td></td>
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<tr>
<td>Nitrogen digestibility (%)</td>
<td>62.1</td>
<td>18.3</td>
<td>24c</td>
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<tr>
<td>Body weight change (kg)</td>
<td>2.9</td>
<td>0.7</td>
<td>4.9</td>
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</tr>
</tbody>
</table>

**N.B.** Mean values from fecal collections made 3, 5, 9 and 13 weeks after infection. *c*, *d*, *f*, *e* means with different letters differ significantly: c < d < f < e (<0.05).

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Rovimix E Type 20W, F. Hoffmann-La Roche and Co., Ltd.
Infection and thereafter every 2 weeks at 0730 hr, before the morning feed. Serum calcium and phosphorus were determined by methods described by Wootton (1974).

Animals were weighed twice each week on a standard time schedule and body weight changes calculated as the regression of body weight on time. Analysis of variance and mean comparisons by Scheffe's test were carried out according to methods described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

The large variations observed for several parameters in the present study are characteristic of infection with *T. colubriformis* (Barker, 1973). High fecal egg counts testify to worm infestation (table 1) and while worm eggs were first detected 3 weeks after infection, numbers did not fluctuate appreciably during the course of the experiment (range 4010 to 6800 eggs/g). Vitamin E and selenium did not influence egg counts and no worm eggs were found in the non-infected groups.

Mean daily feed intake was depressed by about 14% (P<.05) in lambs infected with *T. colubriformis* (table 1), which is consistent with previous findings (Coop et al., 1976; Horak et al., 1968). Supplementary vitamin E and selenium had no effect on intake in non-infected lambs, though there was a trend for higher food consumption during the early stages of infection in those lambs receiving the supplement (figure 1).

There have been many conflicting reports concerning the effects of trichostrongylosis on digestibility. In the present study, DM digestibility was depressed (P<.05) 5 weeks after infection (figure 1) confirming earlier findings by Spedding (1954), but returned to normal within 13 weeks. Nitrogen digestibility was also reduced in infected animals (61.2% vs 68.1%) but showed no sign of recovery towards the end of the experiment, which agrees with published findings of Barger (1973). Reduced digestive ability was probably the result of extensive damage to the gastrointestinal tract caused by the nematode (Reveron et al., 1974). Neither

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**Figure 1.** Daily intake and digestibility of dry matter and nitrogen following infection with *T. colubriformis* and supplementation with vitamin E and selenium.

**Figure 2.** Calcium and phosphorus absorption (% of intake) in lambs following infection with *T. colubriformis* and supplementation with vitamin E and selenium.
DM nor nitrogen digestibility was effected by vitamin E plus selenium supplementation in either infected or non-infected lambs.

The metabolism of phosphorus was more adversely affected than that of calcium following infection (table 2), confirming earlier findings by Reveron et al. (1974). The decline in plasma phosphorus concentration by the third week (figure 3) coincided with the establishment of adult worms in the small intestine (Coop et al., 1976). The maintenance of normal plasma calcium levels agrees with earlier reports (Horak et al., 1968). The suggestion by Field et al. (1975) that the pattern of hypophosphatemia and normocalcemia only occurs in a double deficiency of calcium and phosphorus is supported by the present finding that the apparent absorption of both minerals was depressed in infected lambs (figure 2). The absorption of calcium and phosphorus was probably impaired as a result of the damaging effects of the nematode on the mucosa of the proximal part of the small intestine, a major site of absorption of these minerals (Kay and Pfeffer, 1970). Consequently, the effort to maintain normal serum calcium and phosphorus levels, despite low and
even negative retentions, may have resulted in a decreased rate of bone accretion and an increased rate of reabsorption from the bone (Braithwaite, 1975). The present data therefore suggests that the incidence of bone abnormalities may be exacerbated in young animals suffering from trichostrongylosis.

Mean daily gains of non-infected lambs (23 g) were significantly (P<.01) higher than those of the infected animals, who lost an average of 5 g body weight per day (table 1). Several previous workers, including Andrews et al. (1944), Barker (1973) and Horak et al. (1968) reported similar findings. These workers concluded that the depressed growth rate of infected animals could not be accounted for entirely by the reduced feed intake and that the efficiency of feed utilization may also have been depressed. A comparison of predicted and observed body weight changes based on estimates of the daily intake of metabolizable energy from digestible DM (A.R.C., 1965), shows that the utilization of digested energy was not depressed in infected lambs and that the poorer growth rates could be explained in terms of reduced feed intake. Low body weight gains were not improved by vitamin E plus selenium (table 1), which is consistent with the intake data.

LITERATURE CITED


