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The effect of post-ruminal infusion of protein or energy on the pathology of *Trichostrongylus colubriformis* infection and body composition in lambs

M.D. BOWN, D.P. POPPI AND A.R. SYKES

Animal Sciences Group, Lincoln College, Canterbury.

ABSTRACT

The effect of post-ruminal infusion of protein or energy on the pathology of *Trichostrongylus colubriformis* infection and body composition in lambs was investigated by a comparative slaughter experiment. Lambs infected with 3000 larvae/d were infused with casein (50.5 g crude protein/d; PI) or glucose (isocaloric with casein infusions; EI) or solvent/diluent (SI). Uninfected controls (C) were also infused with solvent/diluent.

Mean live-weight gain±s.e.m. over the 12-week experimental period was 8.0±0.9; 6.9±1.0; 3.7±0.9; 3.1±0.7 kg for C, PI, EI and SI respectively. Protein infusion reduced mean faecal egg output (PI, 1.30±0.57; EI, 2.85±1.08; SI, 2.02±0.37 x 10⁶ eggs/d) and mean total parasite burden at slaughter (PI, 18000±5300; EI, 46000±6700; SI, 39000±6700), though endogenous plasma loss into the gastro-intestinal tract was not affected (C, 73.3±4.3; PI, 251.6±1.2; EI, 281.5±95.3; SI, 200.0±33.0 ml/d).

After increasing for 4 weeks, dry matter intake of infected animals decreased by approximately 22% for PI and EI and by 32% for SI animals. Total ME intake (inclusive of infusions) was C, 0.607; PI, 0.687; EI, 0.704; SI, 0.617 MJ ME/$W^{0.75}$/d suggesting that ME intake of infected animals was not regulated by energy satiety. At slaughter the protein energy:total energy ratio in the empty body was similar for all groups (0.31), but the rate of energy retention over 12 weeks was different (C, 0.077±0.014; PI, 0.094±0.015; EI, 0.069±0.018; SI, 0.041±0.009 MJ/$W^{0.75}$/d). Nitrogen retention was increased 5-fold by protein infusion and was doubled by energy infusion. These results suggest that the effect of the parasite on the host is a result of increased irreversible loss of endogenous protein from the small intestine rather than catabolism of protein to supply energy, and that this effect can be alleviated by protein supplementation.

Keywords Abomasal infusion; casein; glucose; body composition; *Trichostrongylus colubriformis;* endogenous plasma loss; worm burden.

INTRODUCTION

It has long been recognised that the nutritional status of sheep can affect their susceptibility to gastro-intestinal nematode parasitism (Gibson, 1963), such that infected animals on a high plane of nutrition generally display superior growth rates and smaller post-mortem parasite burdens than infected animals on a low plane of nutrition. However, investigations into this phenomenon have usually evaluated the effect of feed quality in empirical terms and have concentrated on the effect of the protein value of the feed (Dobson and Bawden, 1974; Wedrychowicz *et al.,* 1984; Abbott *et al.,* 1985a; b).

Gastro-intestinal parasites appear to exert their effect by increasing endogenous protein losses (plasma, mucus and gastro-intestinal epithelial cells) rather than by malabsorption of protein (Symons and Jones, 1970; Steel *et al.,* 1980; 1982; Poppi *et al.,* 1981; Bown *et al.,* 1984). There is evidence to suggest that the subsequent increase in protein recycling, together with the elevated gastro-intestinal tissue metabolism, increases the energy demand of the animals (Steel and Symons, 1982), though the role of protein or energy supplement-ation or variation in protein and energy supply to the tissues does not appear to have been investigated quantitatively. This is an important consideration in assessing the potential influence of forages differing in the protein:energy ratio of nutrient supply (Cruickshank *et al.,* 1985) on the growth rate of infected animals.

This study investigated the effect of post-ruminal infusion of protein and energy on the protein and energy deposition in lambs with *Trichostrongylus colubriformis,* and the effect on the pathology of parasite infection.

MATERIALS AND METHODS

Animals

Of 52 Dorset Down x Coopworth wethers (mean 30.5 ± s.e.m. 0.44 kg), 8 animals comprised an initial slaughter group (IC), 36 were infected *per os* with 3000 *Trichostrongylus colubriformis* larvae/day for 12 weeks, and the remainder acted as parasite-free controls.

Infusions

Infected animals received a continuous infusion, (via abomasal catheter) of a solution of either sodium caseinate (PI) or glucose (EI; isocaloric with PI) or solvent/diluent (SI). Uninfected controls (C) were also infused with diluent. The level of protein infusion was calculated as the protein required at the small intestine

of infected sheep to increase N retention to that observed in pair-fed control animals, the difference being attributed to irreversible endogenous protein loss. By using the factorial approach (ARC, 1980) and the difference in body protein retention from Sykes and Coop (1976), the required infusion rate was calculated to be 62.5 gCP/d. The mean infusion level achieved throughout the experiment was 50.5 gCP/d. All animals were offered *ad libitum* hammer milled, meadow hay (18.9gN/kgDM; 930gOM/kgDM; 65% OMD).

Measurements

The experiment lasted for 12 weeks after which all animals were slaughtered. Feed intake was measured throughout the experiment and live weight and faecal egg concentration were measured weekly.

Feed digestibility was assessed at weeks 2, 6, 9 and 12 after the first infection. During weeks 6 and 12, plasma loss into the gastro-intestinal tract was measured by reference to the faecal excretion of $^{51}CrCl_3$ after intra-jugular injection (Holmes and MacLean, 1971). Body composition was determined in both initial and final slaughter groups by chemical analysis of fleece-free, whole body homogenates.

RESULTS AND DISCUSSION

The characteristic depression in live-weight gain and feed consumption due to gastro-intestinal parasitism was observed in this experiment. Casein infusion appeared to alleviate the depression in weight gain associated with parasitism whereas glucose infusion did not (Table 1). After increasing for 4 weeks, dry matter intake of infected animals decreased by approximately 22% for PI and EI and by 32% for SI animals. This is similar to the observations of Crompton *et al.* (1981) who showed that protein malnourished rats infected with *Nippostrongylus brasiliensis* showed a greater decline in feed intake than rats fed a casein supplement. Mean metabolisable energy (ME) intakes over the 12 weeks (Table 1) suggest that intake by the SI group was not regulated by energy satiety. Among infected animals, those infused with casein or glucose had a higher feed intake than those infused with solvent/diluent despite their greater overall ME intake due to infusions.

Faecal egg output (PI, 1.30 ± 0.57; EI, 2.85 ± 1.08; SI, 2.02 ± 0.37 x 10^6 eggs/d) and intestinal worm burdens at slaughter (PI, 18000 ± 5300; EI, 46000 ± 6700; SI, 39000 ± 6700) suggest that casein infusion influenced the establishment or maintenance of parasites in the gastro-intestinal tract. This agrees with the work of Gibson (1963) who found that sheep on a higher plane of nutrition displayed a smaller parasite burden at post-mortem than did sheep on a low plane of nutrition. The investigations of Dobson and Bawden (1974), Crompton *et al.* (1981), Duncombe *et al.* (1981) and Abbott *et al.* (1985a;b) suggest that the protein content of the diet influences the capacity for immunological reaction by the host to the parasite though it is not clear whether this affects parasite establishment or maintenance.

Despite the reduced worm burden in protein infused animals, the increase above control levels in plasma loss into the gastro-intestinal tract due to parasitism was similar for all infected animals (C, 73.3 ± 4.3; PI, 251.6 ± 21.2; EI, 281.5 ± 95.3; SI 200.1 ± 33.0 ml/d). If plasma loss was a constant proportion of the

TABLE 1 Mean (s.e.m.) live-weight gain, intake, retention and body composition values of lambs either uninfected (C) or infected and infused wiht casein (PI), glucose (EI) or solvent/diluent (SI).

	C	PI	EI	SI
Live-weight change over 12 weeks (kg)	8.0[a] (0.91)	6.9[a] (0.97)	3.7[b] (0.92)	3.1[b] (0.72)
ME intake (MJ/$W^{0.75}$/d)	0.607[a] (0.0221)	0.687[b] (0.0245)	0.704[b] (0.0175)	0.617[a] (0.0224)
N intake (g/$W^{0.75}$/d)	1.27[a] (0.046)	1.83[b] (0.061)	1.31[a] (0.034)	1.30[a] (0.050)
Energy retention in empty body (MJ/$W^{0.75}$/d)	0.077[a] (0.0142)	0.094[a] (0.0153)	0.069[ab] (0.0179)	0.041[b] (0.0093)
N retention (g/$W^{0.75}$/d)	0.090[a] (0.0113)	0.098[a] (0.0230)	0.054[ab] (0.0247)	0.024[b] (0.0218)
Protein energy: total energy in empty body	0.32 (0.017)	0.30 (0.020)	0.31 (0.017)	0.33 (0.010)

total endogenous loss, then all infected animals had the same metabolic energy demand for endogenous protein recycling and gastro-intestinal tissue metabolism.

The ratio of protein energy:total energy in the empty body was similar for all animals (0.31), though the rate of total energy retention was different (Table 1). If it is assumed that the ME requirement for maintenance (ME_m) was 0.37 MJ ME/ $W^{0.75}$/ d (Alam, 1985), then the efficiency of use of ME for growth (k_g) was 0.32 for control animals. The relative proportion of ME retained in the empty body was reduced by parasitism, though it is not possible to determine whether this was the result of an increase in ME_m or a decrease in k_g. However, it is clear that protein infusion markedly increased the efficiency of retention of ME in infected animals to near that of the uninfected controls. It appears that this was the result of an increase in N retention by protein infused animals. Protein infusion increased N retention in infected animals to a level comparable to that of the controls, whereas glucose infusion elevated N retention only slightly (Table 1). This confirms the suggestion by Steel *et al.* (1982), Poppi *et al.* (1981) and Bown *et al.* (1984), that the major effect of the parasite on the host is to increase the irreversible loss of endogenous protein from the small intestine rather than to increase the tissue catabolism of protein to supply energy for increased recycling of endogenous protein and gastro-intestinal tissue metabolism. Since infection does not affect absorption of protein (Bown *et al.,* 1984), increasing the supply to the small intestine would be expected to alleviate the effect of the parasite on N retention, a result obtained in the present experiment.

The implications for the manipulation of sward composition (e.g. the proportion of legume:grass) to influence the growth rate of infected animals are not simple. Providing the parasite infected animal with a diet supplying a relatively high protein:energy ratio (e.g. legume dominant pastures; Cruickshank *et al.,* 1985) may increase N retention and growth of parasite infected animals by replacing, in part, the irreversible endogenous protein losses. However, the depression in feed intake caused by the parasites remains the major contraint to growth.

In conclusion, it appears that it is possible to manipulate N retention in parasite infected animals by increasing the protein supply to the small intestine.

ACKNOWLEDGEMENTS

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