

# Tissue protein synthesis in lambs infected with *Trichostrongylus colubriformis*\*

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## ABSTRACT

Fractional protein synthesis rates (FSR) were determined in lambs fed fresh sulla (*Hedysarum coronarium*) during an established *Trichostrongylus colubriformis* infection. Forty-eight days after infection, the FSR in the duodenum, ileum, mesenteric lymph nodes, spleen, liver, thymus, muscle and skin was determined. Parasite infection increased the FSR in the smooth muscle of the duodenum and ileum and in the mesenteric lymph nodes. This suggests an increase in amino acid requirement for the synthesis of constitutive proteins in these tissues. However, an established parasite infection did not result in the diversion of amino acids from muscle to the small intestine nor the liver.

KEY WORDS: lambs, sulla, *Trichostrongylus colubriformis*, protein synthesis, tissues

## INTRODUCTION

The effects of parasitic infection on the fractional protein synthesis rates (FSR; % d<sup>-1</sup>) of the gastrointestinal tract (GIT), liver and muscle proteins have been documented in sheep (Jones and Symons, 1982). The FSR from these studies indicate a diversion of amino acids (AA) from growth to the repair of damaged tissue in the GIT and to support altered metabolic activity in the liver (Coop and Sykes, 2002).

The hypothesis of this study was that the presence of an established intestinal parasitic infection would increase the FSR in the small intestine and liver and that the increased AA requirement would be provided by increased mobilization

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of skeletal muscle proteins. The aim of this study was to determine the effects of an established parasitic infection on FSR in the duodenum and ileum, mesenteric lymph nodes, spleen, liver, thymus, muscle and skin of growing lambs.

## MATERIAL AND METHODS

### *Animals, surgical procedures and dietary treatments*

Twelve Romney-cross wether lambs (BW  $33.0 \pm 0.6$  kg) fed fresh sulla were prepared with catheters in the mesenteric artery and in the mesenteric, portal and hepatic veins (Bermingham, 2004). One week after surgery (day 1 of the experimental period) six sheep were given 6000 *Trichostrongylus colubriformis* L3 larvae per day orally for 6 consecutive days while the remaining six sheep were kept as controls. A completely randomised block design was used. Faecal egg counts from each sheep were determined every second day from day 20 to 45 and intestinal worm burdens were measured at slaughter (Bermingham, 2004).

### *Infusion protocol, blood sampling and analytical measurement*

On day 48, the lambs were continuously infused with [3,4-<sup>3</sup>H]-valine (7.6 MBq/h; Amersham Life Science, Buckinghamshire, UK; containing 1.68 mg/L cold valine) into the jugular vein for 8 h. Upon completion of blood sampling, but while the [3,4-<sup>3</sup>H]-valine infusate was still being administered, the sheep were euthanased. Tissue samples were rapidly collected from the sheep in the following order: skin, muscle (*biceps femoris*), liver, duodenum and ileum, mesenteric lymph nodes, spleen and thymus and prepared as described in Bermingham (2004).

### *Calculations and statistics*

The specific radioactivity of plasma valine was calculated by dividing its radioactivity by its concentration and this was used as the precursor pool for the estimation of FSR (Bermingham, 2004). The FSR in tissue samples was determined according to the equation described by Wykes et al. (1996). Statistical analysis was done using a General Linear Model of SAS Version 8. Least squares means and associated pooled standard deviation are reported. Probabilities lower than 0.05 indicate a significant change, while values between 0.05 and 0.10 indicate a trend.

## RESULTS

Dosing lambs with infective L3-*Trichostrongylus colubriformis* larvae resulted in a parasite burden (245 vs 17600 (SD 7000) worms). Dry matter intake over the experiment (769 vs. 689 (SD 47) g DM/d) and the liveweight gain over the last 20 days of the experiment (50 vs -50 (SD 70) g/d) tended to be lower in

the parasitized lambs. The FSR in the smooth muscle of the duodenum and ileum and in the mesenteric lymph nodes was increased in the infected lambs (Table 1), however, whole intestinal tissues were not affected. There was no effect of infection on the FSR in the spleen, liver, thymus, muscle or skin (Table 1).

Table 1. Fractional protein synthesis rates (% d<sup>-1</sup>) of tissues in lambs fed fresh sulla (*Hedysarum coronarium*) during an established *Trichostrongylus colubriformis* infection

Tissue	Control n=6	Parasite n=6	Pooled standard deviation	P
Duodenum whole	23.9	23.8	9.0	0.98
Duodenal smooth muscle	3.4	7.4	2.5	0.03
Ileal whole	11.6	12.0	5.8	0.92
Ileal smooth muscle	2.4	4.0	1.0	0.03
Mesenteric lymph nodes	10.9	20.8	5.6	0.00
Spleen	5.1	5.6	2.4	0.95
Liver	11.4	14.7	6.3	0.38
Thymus	15.9	15.6	5.9	0.94
Muscle	0.5	0.6	0.6	0.84
Skin	3.8	3.3	1.5	0.57

## DISCUSSION

The presence of an established parasitic infection in the small intestine of lambs fed sulla increased FSR in duodenal and ileal smooth muscles. This could be attributed to an increase in sloughed cells caused by the establishment of parasites in the intestinal tissue (Coop and Angus, 1975). Increased FSR in the intestine suggests an increased AA requirement for constitutive proteins during parasitic infection to support the re-establishment of intestinal integrity. Increased FSR in the mesenteric lymph nodes was also observed during parasitic infection. This suggests an increased AA requirement for the synthesis of constitutive proteins involved in mounting and controlling the immune response during parasitic infection.

As feed intake was reduced during parasitic infection, these additional requirements were not met by an increase in dietary AA availability, suggesting that there was a mobilization of AA from protein stores elsewhere in the body. Reduced liveweight gain over the last 20 days of the experiment agrees with this explanation although the FSR of the skeletal muscles was not affected. However, absolute protein synthesis would likely be decreased in these animals. No effect of infection on the FSR of skeletal muscles contradicts other studies where a decrease in muscle FSR during parasitic infection was observed (Jones and Symons, 1982). Reduced muscle protein synthesis in parasitized animals is often accompanied by an increase in protein degradation (Jones and Symons, 1982) and most likely,

more AA are released from the skeletal muscle. In the current study, however, the net flux of total AA across the hind limbs was similar between control and infected animals (Bermingham, 2004) and this indicates that the skeletal muscles are unlikely to be the source of additional AA.

## CONCLUSIONS

The presence of an established parasite infection in lambs fed fresh *Sulla* resulted in an increase in the FSR of the intestinal tissues. This may be due to an increase in the requirement of AA for the synthesis of constitutive proteins in these tissues. An established parasite infection did not appear to result in the repartitioning of AA from the skeletal muscles to the small intestine.

## REFERENCES

- Bermingham E.N., 2004. The metabolic cost of an intestinal parasite infection on amino acid kinetics in sheep fed fresh forages. PhD. Thesis, Massey University, Palmerston North (New Zealand)
- Coop R.L., Angus K.W., 1975. The effect of continuous doses of *Trichostrongylus colubriformis* larvae on the intestinal mucosa of sheep and on liver vitamin A concentration. *Parasitology* 70, 1-9
- Coop R.L., Sykes A.R., 2002. Interactions between gastrointestinal parasites and nutrients. In: M. Freer, H. Dove (Editors). *Sheep Nutrition*. CSIRO Publishing, Victoria (Australia), pp. 313-331
- Jones W.O., Symons L.E.A., 1982. Protein synthesis in the whole body, liver, skeletal muscle and kidney cortex of lambs infected with *Trichostrongylus colubriformis*. *Int. J. Parasitol.* 12, 295-301
- Wykes L.J., Fiorotto M., Burrin D.G., Del Rosario M., Frazer M.E., Pond W.G., Jahoor F., 1996. Chronic low protein intake reduces tissue protein synthesis in a pig model of protein malnutrition. *J. Nutr.* 126, 1481-1488