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SCIENCE DIRECT
Veterinary Parasitology 134 (2005) 99–109
veterinary parasitology
www.elsevier.com/locate/vetpar

Influence of dietary protein supply on resistance to experimental infections with *Haemonchus contortus* in Ile de France and Santa Ines lambs

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Received 27 October 2004; received in revised form 20 March 2005; accepted 28 May 2005

Abstract

The effect of *Haemonchus contortus* infection in sheep fed with a moderate and high protein content diet was evaluated in two breeds of sheep. Forty-eight Ile de France and Santa Ines lambs were maintained indoors since birth, in worm-free conditions. The lambs were allocated after weaning in four groups of six animals per breed, which were either infected or remain uninfected and given access to either a moderately or highly metabolizable protein diet. The moderately and highly metabolizable protein diets were calculated to supply 75 and 129 g metabolizable protein per kg of dry matter (MP/kg DM), respectively. The infection consisted of a trickle infection with 300 infective larvae, three times a week, for 12 weeks. Significant differences were observed for mast cell, globule leukocyte and eosinophil counts in the abomasal mucosa of the infected groups compared to the control of both breeds ($P < 0.05$), regardless of the diet supplied. Significantly higher IgA anti-L5 antibody was detected in the infected Santa Ines groups than in the infected Ile de France groups ($P < 0.05$). Increased metabolizable protein supply resulted in larger body weight gain and higher packed cell volumes for both breeds ($P < 0.05$). Both breeds showed an increased ability to withstand the pathophysiological effects of *H. contortus* infection when given access to the highly metabolizable protein diet. However, increased metabolizable protein supply resulted in reduced worm burdens in Santa Ines lambs but not in the Ile de France lambs ($P < 0.05$). The present results show that the increase in protein content in growing lamb diets may benefit resistance and resilience to gastrointestinal parasites but that these benefits may vary among breeds.

Keywords: Sheep-nematoda; *Haemonchus contortus*; Breed; Nutrition; Resistance

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doi:10.1016/j.vetpar.2005.05.068

1. Introduction

Infections caused by gastrointestinal nematodes are the major constraint in sheep production. In locations with warm weather, *Haemonchus contortus* is the most important species. The prophylaxis of haemonchosis has been jeopardized by the appearance of nematodes with resistance to anthelmintics (Amarante et al., 1992; Echevarria et al., 1996).

There are several measures that can be implemented to reduce the dependence of anthelmintics in the control of nematode parasites. Such measures include the breeding of genetically resistant animals, and the improvement of the quality of the food supplied to sheep. Recently, several studies have indicated that improvements in nutrition, especially in the metabolizable protein content of the diet, can influence the host response against primary and secondary infections and reduce the pathophysiological changes associated with haemonchosis in genetically susceptible and genetically resistant animals (Abbott et al., 1985; Wallace et al., 1995, 1996, 1999).

The level of nutrition can influence the resilience and resistance of the host to parasitic infection. Resilience can be considered as the host's ability to maintain a reasonable level of productivity in the face of a parasitic challenge, and resistance is a measure of the host's ability to limit the establishment, growth rate, fecundity and/or persistence of a parasite population (Albers et al., 1987).

The degree of genetic resistance of the host may influence the effect of the supplementation in the response to infections (Wallace et al., 1995, 1996). After artificial infection with *H. contortus*, different responses were reported in lambs of the Scottish Blackface and Hampshire Down breeds, respectively, resistant and susceptible, when they were supplied with a basal diet or a diet supplemented with soybean meal. While the highly metabolizable protein diet did not influence the faecal egg counts (FEC) and worm burdens in Scottish Blackface lambs, in Hampshire Down lambs the higher protein diet reduced the mean FEC between 30 and 70 days after infection (Wallace et al., 1995, 1996).

Sheep of the Santa Ines breed originated from the northeast of Brazil but has been widely distributed throughout the southeast region in the last few years. Recent studies with animals raised on pasture showed greater resistance of Santa Ines lambs and ewes to *H. contortus* infections than sheep of European breeds, common in the same region (Rocha et al., 2004; Amarante et al., 2004).

The aim of the present study was to investigate the effect of metabolizable protein supply on the resilience and resistance of the Santa Ines and Ile de France lambs towards an experimental infection with *H. contortus*. We hypothesized that the metabolizable protein supply would result in an improvement of the resistance in lambs of the more susceptible breed, Ile de France, while the benefit would be marginal in the Santa Ines, the more resistant breed.

2. Materials and methods

2.1. Animals and experimental design

Ile de France and Santa Ines lambs were purchased from two farms located in São Paulo State, Brazil. Twenty-four Ile de France and 24 Santa Ines male lambs, reared in helminth-free conditions, were used. In each breed, the lambs descended from two rams. The lambs and their dams were kept housed. Lambs were weaned at 60 days of age. In the lactation period, the lambs had access to concentrate (Ração Noel®, Cafenoel) and Tifton hay ground. The lambs were vaccinated against clostridiosis (Sintoxan®, Merial) at 60 days of age and again 30 days later.

After weaning, the Ile de France and Santa Ines lambs were weighed and allocated into four groups of six animals each, balanced according to body weight.

Table 1
Experimental groups ($n = 6$), breed and diet of sheep infected with *Haemonchus contortus* and non-infected control

Breed	Treatment	Diet (level of metabolizable protein)
Ile de France	Control	Moderate
Ile de France	Control	High
Santa Ines	Control	Moderate
Santa Ines	Control	High
Ile de France	Infected	Moderate
Ile de France	Infected	High
Santa Ines	Infected	Moderate
Santa Ines	Infected	High

Moderate and high diets had, respectively, 75 and 129 g of metabolizable protein/kg of dry matter.