Establishment of resistance to *Haemonchus contortus* by Saanen kids

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ABSTRACT

An experiment was conducted to examine the ability of Saanen kids to develop an effective resistance to re-infection by *Haemonchus contortus*. Kids were divided into three groups. Those in Groups I and III had received colostrum at birth while those in Group II were removed from their dams at birth in order to deprive them of colostrum. All kids were reared in the absence of parasites. At the start of the study they were 10-14 weeks of age. Each animal was given 350 infective larvae of *H. contortus* per kg liveweight during weeks 0, 6 and 17. During week 16 all kids in Group III were treated with levamisole to remove infections prior to re-infection. Faecal nematode egg counts (FEC) were determined at weekly intervals throughout the trial. All animals were killed to determine worm burdens 8 weeks after the final dosing with larvae.

FEC of all groups peaked 5-6 weeks after each infection. Re-infections at weeks 6 and 17 were followed by continued declining egg counts in all three groups. Although worm counts for the three groups were not significantly different, establishment rates based on total larvae given after anthelmintic treatment were higher in Group III (15.2%) than in Group I (7.0%) or Group II (6.0%) even though both had remained untreated. Female worms dominated males when infections were superimposed (Group I - 1:0.42; Group II - 1:0.44) however, females and males were found in roughly equal proportions when infections were removed by anthelmintic prior to challenge at 17 weeks (Group III - 1.06:1).

These data suggest that, in Saanen kids, recruitment into the population is affected by repeated exposure to *H. contortus* in the presence of an existing worm burden. One explanation is that the natural death rate may be similar to the recruitment rate however, given the similarity in worm numbers and the continuing decline in FEC across treatments, worm fecundity would have to have been depressed dramatically by some mechanism in order to effect this result. Further work is on-going to resolve these and other issues.

Keywords: *Haemonchus contortus*, goats, resistance, Saanen, kids, repeated infection.

INTRODUCTION

Sheep acquire a strong host resistance to *Haemonchus contortus* after 9-10 months of age. It is associated with the exposure, uptake and establishment of infective (L3) larvae (Benitz-Usher *et al.* 1977). Establishment and development of *H. contortus* appears to be similar in goats and sheep (Rahman and Collins 1990). Even so, development of resistance to this abomasal nematode by Saanen goats remains questionable. In field studies, Le Jambre and Royal (1976) found goats had higher worm burdens than sheep exposed to the same mixed grazing challenge. In New Zealand, experimental studies involving challenge with 200 L3 larvae of *H. contortus*, 3 times per week over 10 weeks showed that vaccination had no effect on the level of infection following anthelmintic treatment and subsequent challenge (Pomroy and Charleston 1989). The same study also suggested that resistance was apparently unaffected by host age since both five and a half and 14 month old Saanen wethers yielded similar results.

The present study was designed to investigate the effects pulsed experimental exposure with *H. contortus* has on acquisition of host resistance to infection by Saanen goat kids.

MATERIALS AND METHODS

Sixteen Saanen buck kids reared in the absence of parasites were weaned at 18 kg liveweight or 8-9 weeks of age. Twelve had been removed from their dams within 72 hours of birth and the remaining four were taken prior to suckling so as to preclude ingestion of colostrum. The kids were reared on cows milk, supplemented with hay, silage and goat nuts (NRM Feeds) from an early age. Water was available continuously. All kids were aged between 10 and 14 weeks and fully conditioned onto feed and housing at commencement of the study.

The trial was initiated on concrete floored pens until adverse weather forced relocation of the study indoors. From this time, all stock were maintained on wire mesh above concrete floors and each was provided 1 kg pelleted lucerne daily (Elders; approximately 18% crude protein). To preclude accidental re-infection pens were cleaned daily throughout the trial.

The anthelmintic-susceptible sheep strain of *H. contortus*, WA476, which was used in this study had been passaged through goats. Animals in Groups I (colostrum-competent, n=6) and II (colostrum-deprived, n=4) were given 350 *H. contortus* L3 larvae per kg liveweight by a single oral dose at weeks 0, 6 and 17 of the study. Kids in Group III (colostrum-competent, n=6) were infected with *H. contortus* at the same times but infections were abbreviated with levamisole (Nilverm, 8.0mg/kg) during week 16. All larvae were given orally in water.

Faecal nematode egg counts (FEC) were undertaken by the modified-McMaster technique at weekly intervals.

All kids were humanely slaughtered by intravenous sodium pentabarbitone overdose 8 weeks after the last infection to assess parasite infectivity. Worm burdens were estimated by the methods of Robertson and Elliott (1966). Washed abomasa were incubated in 1.5 l of normal saline at 40°C for five hours to recover and estimate numbers of immature larval stages (Downey 1980).

Data were analysed by least squares analysis of variance (SAS 1985). FEC and worm counts were transformed, $Log_{10}(x+1)$, to normalise distributions prior to analysis. Establishment rates and sex ratios were normalised using the arcsine (x) transformation prior to determining statistical significance.

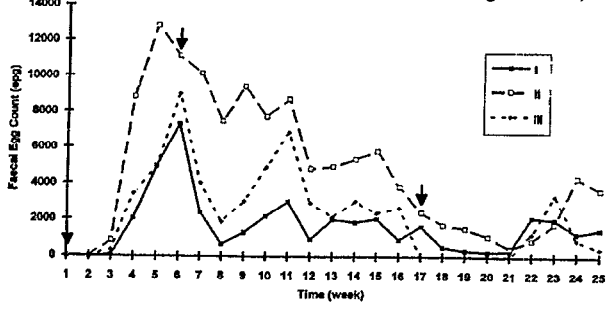
RESULTS

Two kids from Group I were unavailable for slaughter due to prior commitments for the animals. One kid in each of Groups II and III died during the experiment. Death was apparently unrelated to parasite burden.

At commencement of the study, mean liveweights were 20.3kg, 16.0kg and 20.5kg (average s.e. 0.47kg) for Groups I-III, respectively. Colostrum-deprived kids were significantly lighter ($P<0.02$) at the commencement of the study. Weight gains recorded at the end of the trial were 4.2kg, 5.2kg and 5.7kg for Groups I-III, respectively and were non-significant.

No significant difference in mean FEC between treatment groups was observed throughout the experiment (Figure 1). FEC peaked 5-6 weeks after larvae were initially given. Despite subtle rises in FEC 5-7 weeks after re-infection the general trend was downward . Changes were much more pronounced after infection at 17 weeks.

FIGURE 1: Back-transformed geometric mean faecal nematode egg counts of Saanen kids given 350 infective larvae/kg of *Haemonchus contortus* at 0, 6 and 17 weeks as denoted with arrows. (Groups I, II and III given 350 infective larvae/kg during weeks 0, 6 and 17; Group II deprived of colostrum; Group III infections treated during week 16.)



Immature worms collected following incubation of abomasums made up less than 1% of the total worms recovered (0-100 L4 larvae). Mean numbers of adult parasites did not vary significantly between the treatment groups (Table 1). Worm burdens were variable ranging between 100 and 4100 (Group I), 600 and 1600 (Group II) and 200 and 2800 (Group III). Based on total numbers of L3 larvae given after any treatment with anthelmintic, establishment rates were extremely variable, 7.0%, 6.0% and 15.2% for Groups I-III, respectively (Table 1). These were significantly different ($P<0.02$). Sex ratios (male/female) for Groups I, II and III were 0.42:1, 0.44:1 and 1.06:1, respectively (Table 1).

TABLE 1: Arithmetic least squares mean *Haemonchus contortus* worm counts, establishment rates and sex ratios in Saanen kids.

Treatment Group	Worm count Male	Est Female	M/F Total	Rate	Ratio
I	700	900	1725	7.0	0.42
II	300	800	1100	6.0	0.44
III	640	660	1533	15.2	1.06
P	ns	ns	ns	0.02	ns

Groups I, II and III given 350 infective larvae/kg during weeks 0, 6 and 17; Group II deprived of colostrum; Group III infections treated during week 16.

DISCUSSION

Although establishment of a single experimental infection after removal of existing worm burdens was highly variable, averaging only 15.2%, it is somewhat comparable to that demonstrated by various researchers following infection of milking goats with *H. contortus* (Colglazier *et al.* 1967; Al-Quaisy *et al.* 1987; Pomroy and Charleston 1989; Rahman and Collins 1990). This represents only approximately one third the rate reported previously (McKenna and Watson 1987).

Colostral-deprivation clearly affected growth before the study commenced. It was also associated with an elevated FEC through the primary and secondary infections. However, although not significant, there was a tendency for these kids to have lower worm numbers. The lack of statistical significance may be a feature of individual animal variations within groups and small group sizes.

Strong resistance to re-infection generally develops in sheep following periods of challenge and infection by nematode parasites including *H. contortus*, more so when infections are allowed to persist (Barger 1988). The current experiment suggests that such may be the case with Saanen kids repeatedly exposed to *H. contortus*. Only 6-7% of the total number of larvae given at 3 discrete times were recovered as adult worms even though 15.2% established after earlier infections were removed. Furthermore, females outnumbered males over 2 to 1 when infections were superimposed without anthelmintic treatment.

Changes in nematode sex ratios have been shown to be associated with acquisition of immunity to infection by lambs (Dineen and Windon 1980). Infection of sheep generally, is reflected by equal numbers of male and female nematodes. Repeated challenge leading to host resistance often is accompanied with a concurrent reduction in numbers of males as immunity approaches. In the current study, sex ratios found in Groups I and II suggest that a similar pattern may exist. Other studies conducted in our laboratory have demonstrated equal sex ratios in goats following single exposures with *Haemonchus* (Watson, unpubl.).

Failure to maintain challenge commonly causes reversion to susceptibility by sheep. Furthermore, resistance can

apparently be triggered by an increased intake of larvae. Adequate immunogenic stimulation must be available in order that the host can mount responses required to induce resistance. During the current study moderate numbers of larvae were used to dose kids in pulsed vaccinating doses, 6 and 17 weeks after initial experimental infections. Goats can apparently restrict levels of infection by *H. contortus*, at least under the conditions and regimes used in the present study. These results contradict the findings of Pomroy and Charleston (1989). Explanations may rest in the levels of exposure and the recruitment and death rates for established worm populations in this particular host.

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