Response of calves to different levels of mixed species gastrointestinal parasite infection

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ABSTRACT

The effect of different levels of parasite infection was studied in 5-month old calves. Eighty-four calves were dosed with 0, 1000, 2000, 4000, 7000 or 10000 parasite larvae (L3) per day for 6 weeks (90% *Cooperia*, 10% other species), or were drenched 3-weekly, whilst grazing in one mob. Worm burdens were then determined in 3 calves per treatment. The remaining calves then grazed together for 11 weeks to determine carryover effects, during which they were all drenched at weeks 5 and 9. At the end of L3 dosing, there were no liveweight differences, but by week 5 of the carryover period, calves receiving 10000 L3 per day were 12 kg lighter than drenched or 0 L3 calves ($P<0.05$). This difference was maintained for the rest of the experiment. *Cooperia* burdens (76000/calf) in 10000 L3 calves were at least double those on all other treatments ($P<0.001$). There was no relationship between L3 dose and worm burden for the other parasite species, or L3 dose and faecal egg count. This experiment has shown that for calves dosed with less than 10000 L3 per day, drenching does not increase liveweight gain when the parasite larvae are 90% *Cooperia*.

Keywords: calf; *Cooperia oncophora*; liveweight gain; gastro-intestinal parasite.

INTRODUCTION

Gastrointestinal parasites can cause large production losses in weaned calves. Field studies in which anthelmintics have been used have shown liveweight gain (LWG) to improve by 20-65% compared to untreated cattle (Enterocasso *et al*., 1986; Somers *et al*., 1987). But these studies did not determine how many or what species of parasites the cattle were exposed to. With the rise in anthelmintic resistance (Rhodes *et al*., 2006) and the inability to use anthelmintics in organic farming systems, management practices that eliminate or minimise anthelmintic use are essential. This requires a good understanding of the effects of endoparasites on animal performance.

Cooperia oncophora is the most abundant gastrointestinal parasite on calf-grazed New Zealand pastures (Bissett, 1994), and also the species with the highest level of drench resistance (Rhodes *et al*., 2006). The density of parasite larvae (L3) on pasture varies with climate and stock management, contributing to variation in liveweight performance between farms. Overseas research on the liveweight response of cattle to different doses of L3 has been carried out with parasite naive 3 to 5 month old calves. Coop *et al*. (1979) found calves dosed with 5000 to 20000 *Cooperia oncophora* 5 days per week had a 0.2 kg/day reduction in liveweight gain compared to non-parasitised calves. But gastrointestinal parasite infections in New Zealand cattle normally contain a mixture of *Cooperia* and the abomasal species *Ostertagia ostertagi* and *Trichostrongylus axei.* These abomasal parasites cause greater reductions in liveweight gain than *Cooperia oncophora* (Herlich, 1959; 1965).

This research aimed to determine the response of weaned Friesian bull calves to a *Cooperia* dominant experimental mixed species infection at a range of doses likely to occur under grazing in New Zealand. Unlike previous experiments, the calves were not kept parasite naïve before the experiment began, so had some degree of acquired immunity to parasites.

METHODS

Experimental design, animals and pasture management

Five-month old spring-born Friesian bull calves were stratified by liveweight and allocated to treatments (12 per treatment). Calves received an oral combination anthelmintic drench (100 g/L albendazole & 75 g/L levamisole; Arrest C, Ancare NZ Ltd) to eliminate parasites before the start of dosing.

Calves were orally dosed 2 times per week to the equivalent daily L3 intake per treatment as detailed below for 6 weeks. Infective larvae were 90% *Cooperia oncophora*, 6% *Ostertagia ostertagi*, 1% *Trichostrongylus axei* and 3% other species (not identified). Three calves per treatment (selected with an average liveweight the same as the whole treatment group) were slaughtered in week 7 to determine adult worm burdens. The remaining animals continued to graze together with no L3 dosing for 11 weeks, to determine any carryover effects from the treatments. In week 5 of

the carryover period, all calves were drenched with Arrest C due to high faecal egg counts, then were drenched again 4 weeks later.

Treatments were as follows:

1. No L3 plus anthelmintic. Calves were treated every 3 weeks with Arrest C at a rate of 1 mL/10 kg liveweight of the heaviest animal in this treatment.
2. No L3.
3. 1000 L3 per calf per day (3500/dosing).
4. 2000 L3 per calf per day (7000/dosing).
5. 4000 L3 per calf per day (14000/dosing).
6. 7000 L3 per calf per day (24500/dosing).
7. 10000 L3 per calf per day (35000/dosing).

The experiment was undertaken at Whatawhata Research Centre, Waikato, on rolling hill country. All calves grazed together in one group with an unrestricted allowance of perennial ryegrass based pasture. Paddocks were prepared by grazing with ewes for a minimum of 5 months prior to the experiment to minimise the cattle L3 concentrations on pasture. Calves were shifted to a new paddock at least twice per week and did not graze the same paddock more than once during the experiment, preventing infection from larvae developing from the eggs in their faeces.

Measurements

Pasture L3 measurements were made on pre-grazing herbage pluck samples collected weekly during the dosing period and fortnightly during the carryover period to estimated grazing height. L3 were extracted from pasture (Boom & Sheath, 2007) to determine the concentration of each parasite genus per kg DM. Pasture quality was measured weekly during the dosing period and fortnightly in the carryover period by near infrared spectroscopy (Corson *et al*., 1999) from a sub-sample of the pasture collected for L3 measurement.

Individual animal liveweight was recorded weekly during the dosing period and fortnightly during the carryover period, 24 hours after shifting calves onto a new paddock. Faecal samples were collected per rectum from each calf fortnightly during the dosing period then 4 weekly during the carryover period. Faecal egg counts (FEC) were determined using a modified McMaster method (MAFF, 1997) in which 1 egg counted equated to 50 eggs per gram (epg) of fresh faeces. Larval cultures (pooled within treatments) were undertaken on faecal samples with a positive FEC in weeks 7 and 16 to determine the percentage of each parasite genus from larvae developing from eggs.

In week 7, three calves per treatment were slaughtered to determine worm burdens in the abomasum and small intestine. The procedures used followed the guidelines of Wood *et al*. (1995). Separate samples were collected from fresh intestinal and abomasal washings and from abomasal washings after 24 hours incubation in physiological saline.

Statistical analysis

Data were analysed using one-way analysis of variance for a completely randomised design, using the statistical procedures of Genstat (Version 8.11), with the calf as the experimental unit (12 replicates per treatment). Faecal egg count data were log transformed before analysis. Liveweights were adjusted before analysis using the initial weight as a covariate.

RESULTS

Pastures averaged 9.5 MJ ME/kg DM, 55% neutral detergent fibre and 17% crude protein. Pasture L3 concentrations were very low, averaging 198/kg DM during the dosing period (33% *Cooperia oncophora*, 18% *Ostertagia ostertagi*, 26% *Trichostrongylus* species and 23% other species (including sheep parasites), 20/kg DM during the carryover period (22% *Ostertagia ostertagi*, 41% *Trichostrongylus* species and 37% other species), and 278/kg DM during the drenching period (8% *Cooperia oncophora*, 26% *Ostertagia ostertagi*, 66% *Trichostrongylus* species).

The drenched and 0 L3 treatments maintained similar liveweight gains throughout the experiment (average of 0.55 kg/day over the dosing and carryover period). Calves dosed with up to 10000 L3 per day grew at the same rate as those that were drenched over the first 6 weeks (Figure 1). However, 5 weeks after the end of parasite dosing, the average liveweight of calves that received 10000 L3 per day was significantly ($P<0.05$) lighter than those that received none (Figure 1). At this time, the difference in liveweight between the heaviest and lightest treatment was only 12 kg. Over the dosing period and first 5 weeks of the carryover period, this equates to a reduction in liveweight gain of 0.16 kg/day. The difference in liveweight was maintained for the following 6 weeks, when all calves had been drenched.

Low faecal egg counts (<100 epg) were maintained on the drenched treatment. Faecal egg counts for all other treatments peaked between weeks 8 and 10, at above 600 epg (Figure 2). All treatments were drenched in week 11 due to high FEC. There was no clear relationship between L3

dose and FEC, but the estimated percentage of eggs as *Cooperia* increased with increasing L3 dose (Table 1).

The number of *Cooperia* in the fourth larval stage (L4) in calves in week 7 increased linearly with increasing L3 dose (Table 2). Total *Cooperia* burdens in the 10000 L3 treatment (64000 worms) were at least double those of all other treatments ($P<0.001$), and all treatments dosed with more than 1000 L3 per day had greater *Cooperia* burdens than those that were not dosed. Some *Cooperia punctata*, *Ostertagia, Haemonchus* and *Trichostrongylus* were also found in the small intestines. All treatments had similar total abomasal worm burdens (26000-48000). Total worm burdens in the 10000 L3 treatment were greater than for all other treatments except 4000 L3 ($P<0.05$). The 0 and 1000 L3 treatments had a lower percentage of abomasal worms as *Ostertagia* (18 and 12%, respectively) than treatments with higher L3 dose rates (48 to 61%). The remaining abomasal worms were predominantly *Trichostrongylus*, with *Haemonchus* making up less than 10% of abomasal worms in all treatments.

Figure 1: Average liveweight of calves drenched 3-weekly or dosed with 0, 1000, 2000, 4000, 7000 or 10000 L3 per day for 6 weeks. Error bars represent s.e.d.

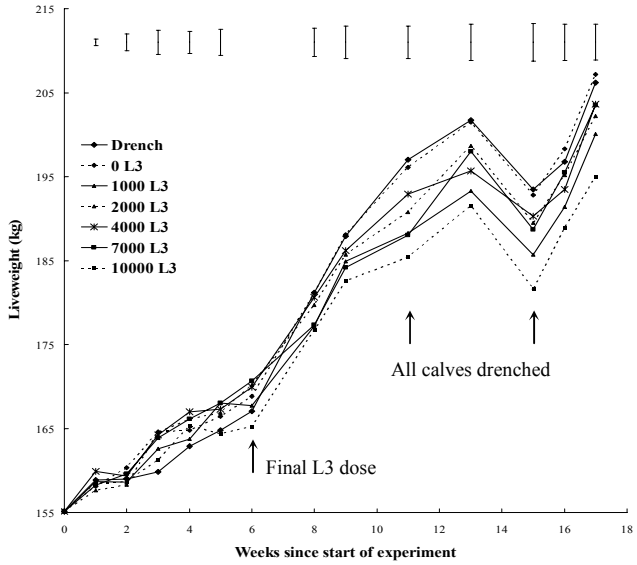
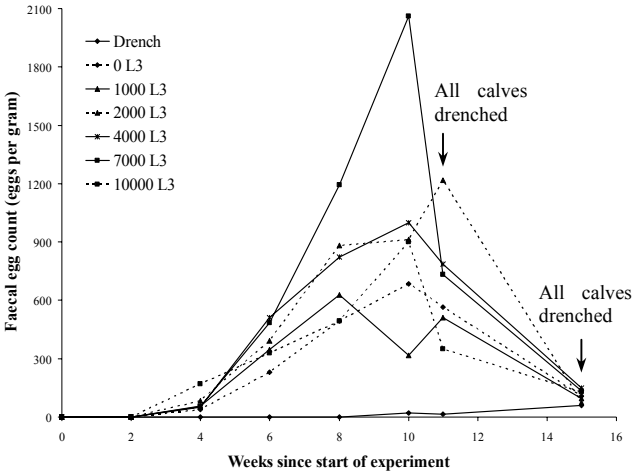


Figure 2: Average faecal egg count (back transformed data) of calves drenched 3-weekly or dosed with 0, 1000, 2000, 4000, 7000 or 10000 L3 per day for 6 weeks.



DISCUSSION

The low pasture L3 contamination had little effect on animal performance, as the 0 L3 calves had the same average liveweight gain as calves that were regularly drenched. The pasture quality and feed supply was sufficient for liveweight gain of approximately 0.5 to 0.6 kg/day, as was achieved by the non-parasite dosed animals.

Faecal egg count was not a good indicator of animal performance. All non-drenched treatments had high FECs, but the three treatments with the highest peak FEC had similar liveweight gain to the drenched treatment. The lack of relationship between faecal egg count and larval dose rate in our experiment has previously been reported by Coop *et al*. (1979) with pure *Cooperia oncophora* infections in parasite naïve calves.

As total abomasal worm burdens were similar between treatments, the major difference between treatments was the *Cooperia* infection level. Coop *et al*. (1979) found no relationship between the rate of larval intake and worm burden for pure *Cooperia* infections. This is contrary to our findings of immature *Cooperia* burdens increasing

Table 1: Genus of L3 larvae cultured from pooled faecal samples of calves receiving 0 to 10000 L3 per day.

	0 L3	1000 L3	2000 L3	4000 L3	7000 L3	10000 L3
Week 7						
% *Cooperia*	26	40	52	47	60	63
% *Ostertagia*	39	43	27	27	28	26
% *Trichostrongylus*	35	17	21	26	12	11
Week 16						
% *Cooperia*	27	37	37	55	54	57
% *Ostertagia*	38	44	39	36	30	28
% *Trichostrongylus*	35	19	24	9	16	15

Table 2: Worm burdens of calves dosed with 0 to 10000 L3 per day for 6 weeks.

Treatment	*Cooperia* L4	*Cooperia* adult	Total *Cooperia*	Total abomasal worms	Total worms
0 L3	1067[a]	1833[a]	2900[a]	31460[a]	34360[a]
1000 L3	1527[a]	8587[ab]	10113[ab]	36120[a]	46233[a]
2000 L3	1760[a]	27040[bc]	28800[b]	26567[a]	55367[a]
4000 L3	2740[ab]	29487[c]	32227[b]	48107[a]	80333[ab]
7000 L3	5333[b]	23740[bc]	29073[b]	26353[a]	55427[a]
10000 L3	12367[c]	64000[d]	76367[c]	32180[a]	108547[b]
P	<0.001	<0.001	<0.001	0.921	0.048
LSD	3517	20311	22716		49177

Data with the same superscript within columns are not significantly different.

with increasing L3 dose. Total *Cooperia* burdens increased substantially between the 1000 and 2000 L3 dose, and the 7000 and 10000 L3 dose. This difference may be due to the substantially higher *Cooperia* burdens in our experiment compared to that of Coop *et al*. (1979). The very high *Cooperia* burden in the 10000 L3 calves compared to all other treatments was associated with a reduction in liveweight gain compared to drenching or not being dosed with parasites.

Despite our higher *Cooperia* burdens, liveweight gain was not affected to the same degree as the parasite naïve calves in the study of *Coop et al*. (1979), who found a reduction in liveweight gain of 0.20 to 0.23 kg/day with 3500 to 14000 *Cooperia* L3 per day versus no parasites. This could be due to the previous exposure to parasites in our calves, allowing some acquired immunity before the experiment began and the shorter trial period may not have allowed full expression of the response. The good protein supply in our experiment (17% of DM) may have also helped animals cope better with parasites (van Houtert & Sykes, 1996) than the calves in the experiment by *Coop et al*. (1979), which had a diet with only 13.5% crude protein.

Our experiment showed no benefit to drenching unless calves received more than 7000 L3/day. Boom *et al*. (2006) found intensive beef farms in New Zealand have an average of 1735 L3/kg DM. For young calves eating 4-6 kg DM this would generate average L3 intakes of about 7000-10000 per day. This suggests if efforts were concentrated on reducing pasture L3 contamination (as was achieved in this experiment), production losses from parasitism could easily be prevented without drench use when *Cooperia* is 90% or more of the pasture L3 population.

The species mix of parasites on pasture will vary with climate, drench and grazing history. In contrast to this experiment (90% *Cooperia*), a similar experiment with infections of 75% *Cooperia* showed liveweight gain was affected at dosing rates of only 4000 L3 per day (Burggraaf *et al*. 2007). Therefore, the higher the proportion of *Cooperia* L3 in a mixed infection, the less likely there will be an effect on liveweight gain. This agrees with pure infection experiments, where *Ostertagia* and *Trichostrongylus* infections have a greater effect on production than *Cooperia* (Herlich, 1959; 1965; Michel, 1969). This research shows the importance of understanding the concentration and species of parasites on pastures to most effectively manage stock with minimal drench use.

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