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Short Communication

Efficacy of pyrantel tartrate against experimental infections with *Haemonchus contortus*, *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* in goats

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Abstract

The efficacy of pyrantel tartrate was evaluated in goats against induced infections with *Haemonchus contortus*, *Teladorsagia circumcincta* and *Trichostrongylus colubriformis*. All the strains were of sheep origin and tested for susceptibility to pyrantel tartrate in sheep at the standard dose rate (20 mg kg^{-1}) prior to the infection of goats. Fifteen French Alpine female goats were inoculated with the three nematode species. On Day 25 post-infection, goats were randomized into an untreated control group and two pyrantel treatment groups (20 mg kg^{-1} bodyweight once, and 40 mg kg^{-1} bodyweight as two doses 24 h apart). The goats were killed and processed for worm recovery 10 days after treatment. The two dose rates achieved high and similar levels of efficacy (> 96%) against *Haemonchus contortus* and *Teladorsagia circumcincta*. Against *Trichostrongylus colubriformis*, however, pyrantel tartrate was less effective at both dose rates as worm reductions ranged from 55 to 62%.

Keywords: *Haemonchus contortus*; *Teladorsagia circumcincta*; *Trichostrongylus colubriformis*; Goat; Pyrantel tartrate; Control methods-Nematoda

1. Introduction

Gastrointestinal nematode infections are of great concern in grazing dairy goats in France as they are highly prevalent, especially *Trichostrongylus colubriformis*, *Teladorsagia circumcincta* and *Haemonchus contortus* (Chartier and Reche, 1992) and responsible for a decrease in milk yield and milk fat production in high-producing animals (Hoste and

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Chartier, 1993). The control of nematode infections in goats is still very reliant upon the use of anthelmintics in this country. Anthelmintic drench failures in goats have been reported by numerous workers (Gillham and Obendorf, 1985; Elliot, 1987; McKenna and Watson, 1987; Watson and Hosking, 1988; Charles et al., 1989). Although the occurrence of anthelmintic resistance of nematodes in goats is recorded at a high level in some countries (Hong and Hunt, 1993; Scherrer et al., 1989), the lack of effectiveness of anthelmintics is also due to the use of inappropriate dose rates in this host species (McKenna, 1984). Thus there is a need for anthelmintic efficacy testing by means of controlled slaughter trials using parasites of defined susceptibilities. Such studies have been carried out for some benzimidazoles, levamisole and ivermectin (Swan and Gross, 1985; Coles et al., 1989; Sangster et al., 1991) but are still lacking for tetrahydropyrimidines (pyrantel and morantel). This paper describes the results of a slaughter trial in goats in which the efficacy of pyrantel tartrate at two dose levels was established against induced infections of adult *Haemonchus contortus*, *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* of sheep origin and known susceptibility.

2. Materials and methods

Fifteen 3–6-year-old French Alpine female goats raised in a zero-grazing system were purchased from a local producer. Individual coproscopical examinations repeated twice as well as the type of management used (Chartier et al., 1992) allowed us to assess that the animals were free of trichostrongyle infections. Goats were housed in concrete pens and were given barley hay with commercial concentrate and water ad libitum. *Haemonchus contortus*, *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* were INRA (Institut National de la Recherche Agronomique, France) strains of sheep origin. Before the experiment, each strain was checked for susceptibility to pyrantel tartrate in sheep. One 4-month-old lamb was used for each strain. Lambs were infected with 10 000 third-stage larvae (L_3), drenched with pyrantel tartrate (Exhelm; Pfizer-France) at the commercial dosage (20 mg kg^{-1} bodyweight (BW)) at Day 25 post-infection and then necropsied 10 days after treatment. For each nematode species, efficacy was 100%. Each goat was inoculated orally with 10 000 *Trichostrongylus colubriformis* L_3 on Day -1 and 5000 *Haemonchus contortus* and 10 000 *Teladorsagia circumcincta* L_3 on Day 0. On Day 25 post-infection, goats were weighed and allocated at random into three groups. Group 1 was not treated, Group 2 was given 20 mg kg^{-1} BW pyrantel tartrate once and Group 3 was given 40 mg kg^{-1} BW as two doses 24 h apart. Ten days after treatment, all animals were killed, their abomasa and small intestines removed and subjected to standard worm counting procedures with one 1:10 aliquot microscopic count (Ministry of Agriculture Fisheries and Food, 1977). Percentage efficacy of the treatments was calculated using the following formula:

$$\text{Efficacy } (\%) = \frac{\text{Mean no. nematodes in controls} - \text{Mean no. nematodes in treated animals}}{\text{Mean no. nematodes in controls}} \times 100$$

Worm burden comparisons between groups were made by a Mann–Whitney test.

Table 1
Post-mortem worm counts, group means and percentage reductions with pyrantel tartrate (20 and 40 mg kg^{-1}) compared with control goats

Group	Tag No.	*H. contortus*	*T. circumcincta*	*T. colubriformis*
Untreated control	006	520	3020	3080
	025	730	2770	3600
	849	170	3000	3500
	966	200	3510	3720
	9107	330	2350	3760
Group mean		390 [a]	2930 [a]	3532 [a]
Pyrantel tartrate 20 mg kg^{-1}	022	0	110	2500
	107	0	210	1310
	365	0	90	2780
	773	0	20	10
	8176	0	20	80
Group mean		0[b]	90[b]	1336[b]
Reduction (%)		100	96.9	62.2
Pyrantel tartrate 40 mg kg^{-1}	026	0	50	2260
	030	0	50	1130
	142	0	30	1960
	8144	0	40	1130
	8161	0	60	1470
Group mean		0[b]	46[b]	1590[b]
Reduction (%)		100	98.4	55.0

[a,b] Means in the same column with different superscripts are significantly different ($P<0.05$).

3. Results

The number of each parasite found in individual goats together with arithmetic group means, percentage reductions and the results of statistical analysis are shown in Table 1. Both dose rates achieved efficacies of 100% and 96% against *Haemonchus contortus* and *Teladorsagia circumcincta*, respectively. Against *Trichostrongylus colubriformis*, however, the drug appeared less effective as reductions only reached 62% for 20 mg kg^{-1} BW and 55% for 40 mg kg^{-1} BW. Nevertheless, *Trichostrongylus colubriformis* burdens were statistically different in both treated groups compared to the control group ($P<0.05$).

4. Discussion

Pyrantel tartrate is a highly effective broad-spectrum anthelmintic with efficacy ranging from 90 to 100% against adult trichostrongylids in sheep (Cornwell, 1966; Euzeby, 1976). In this study, the strains of *Haemonchus contortus*, *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* were of sheep origin and were checked for susceptibility to pyrantel tartrate in sheep at the commercial dose rate of 20 mg kg^{-1} prior to the experimental study in goats. This point is of great concern in goats as it allows a clear interpretation of the lack of effectiveness due to the host (McKenna, 1984). Our results demonstrated that

pyrantel tartrate was highly effective (> 96%) against the two abomasal nematode species at 20 mg kg^{-1} BW but showed a low efficacy against the intestinal nematode species *Trichostrongylus colubriformis*, even at 40 mg kg^{-1}. These data are similar with those of Elliot (1987) conducted in goats with morantel citrate at the standard (sheep) dose rate. This author showed a 100% efficacy of the drug against *Haemonchus contortus* and an efficacy of 68–69% against *Trichostrongylus* spp. (*Trichostrongylus colubriformis* and *Trichostrongylus vitrinus*) and *Teladorsagia circumcincta*, all of these strains being of "known" susceptibility. McKenna and Watson (1987) reported a low efficacy of morantel citrate against *Trichostrongylus colubriformis* (56%) whereas a 96% reduction or more was recorded for *Haemonchus contortus* and *Teladorsagia* spp. in goats. In sheep and cattle, 60% of a pyrantel tartrate dose is excreted unchanged in the faeces and it is assumed that this portion represents unabsorbed rather than biliary-excreted material (Faulkner et al., 1972). On the other hand, morantel tartrate could not be detected in the plasma of goats following oral administration (McKellar et al., 1993). The difference in efficacy against *Trichostrongylus colubriformis* in sheep and goats is difficult to explain if we consider that the activity of pyrantel is due to the unabsorbed drug passing down the gastrointestinal tract. Differences in anthelmintic efficacy between the two hosts have been demonstrated for numerous benzimidazoles, levamisole and clorsulon and have been related to the lower bioavailability of these drugs in goats (Galtier et al., 1981; Bogan et al., 1987; Short et al., 1987; Delatour et al., 1988; Sundlof and Whitlock, 1992). A similar phenomenon may be involved for pyrantel tartrate and comparative studies that evaluate the pharmacokinetics of this drug in both sheep and goats need to be carried out. In France, pyrantel tartrate is the only non-benzimidazole drug approved for use in lactating goats that has a zero milk withdrawal. Thus, as several cases of resistance to benzimidazoles in goat nematodes have been reported in France (Kerboeuf and Hubert, 1985; Hubert et al., 1991; Chartier and Pors, 1994), pyrantel tartrate could represent the best option for worm control, at least during the lactating period. Considering that *Trichostrongylus colubriformis* is highly prevalent and represents 51% of the gastrointestinal worm burden in dairy goats in the western part of France (Chartier and Reche, 1992), the use of pyrantel tartrate cannot be considered adequate for control purposes at any of the dose rates tested.

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