

Short Communication

Efficacy of six anthelmintics against luminal stages
of *Baylisascaris procyonis* in naturally infected
raccoons (*Procyon lotor*)

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Abstract

The efficacy of six anthelmintics against natural infections of *Baylisascaris procyonis* in raccoons ($n = 7$ per drug) was determined in a series of critical tests. The drugs were given via moist cat food as a single dose or once daily for three consecutive days. Raccoons treated with pyrantel embonate ($1 \times 20 \text{ mg base kg}^{-1}$ bodyweight (bwt.)), ivermectin ($1 \times 1 \text{ mg kg}^{-1}$ bwt.), moxidectin ($1 \times 1 \text{ mg kg}^{-1}$ bwt.), albendazole ($3 \times 50 \text{ mg kg}^{-1}$ bwt.), fenbendazole ($3 \times 50 \text{ mg kg}^{-1}$ bwt.) or flubendazole ($3 \times 22 \text{ mg kg}^{-1}$ bwt.) expelled 1–198, 2–24, 2–14, 3–80, 2–70, or 2–35 *B. procyonis* stages, respectively, within the faeces. No roundworm was detected in any raccoon at post mortem examinations 7 days after the end of treatment. These results suggest that any of the six anthelmintics can be used at the dose rates tested in a deworming programme for captive raccoons.

Keywords: *Baylisascaris procyonis*; Raccoon; Control methods-Nematoda; Albendazole; Fenbendazole; Flubendazole; Ivermectin; Moxidectin; Pyrantel embonate

1. Introduction

Baylisascaris procyonis Stefanski and Zarnowski, 1951 is a parasite frequently found in free-ranging populations of the raccoon (*Procyon lotor*); about 70% of adult and more than 90% of juvenile raccoons were found to be infected in certain areas, such as the midwestern and northeastern USA (Kazacos and Boyce, 1989) or central Germany (Bauer et al., 1992). *B. procyonis* can cause ocular and visceral larva migrans as well as fatal cerebrospinal nematodosis in many species of birds and mammals, including man (Kazacos and Boyce, 1989; K uchle et al., 1993). For this reason, raccoons kept in close proximity to humans and

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domestic animals present a potential health hazard to both. Anthelmintic compounds have been scantily tested in raccoons. The objective of the present study was to estimate the oral efficacy of six drugs against natural infections of *B. procyonis* in raccoons.

2. Material and methods

Over a 20 month period raccoons of both sexes and various age were captured alive using box traps from an area on the Eder dam, north Hessen, Germany, where raccoons have been endemic for more than 50 years. Test animals were individually housed in stainless steel cages with a litter tray. They were given water ad libitum and commercial moist cat food once daily. An acclimatisation period of 1–3 weeks was allowed to adapt to the new environment and test diet. Faeces samples were collected from each animal 1–3 days before treatment and examined qualitatively for worm eggs by a flotation technique using a zinc chloride solution ($d=1.28$) to confirm patent *B. procyonis* infections. Seven infected raccoons were accumulated and then assigned to the same treatment group. A total of 42 raccoons weighing 2–10 kg on the day of (first) treatment were selected for the trials.

Six compounds were tested: pyrantel embonate as a 43.9% paste formulation for horses (Banminth[®] Paste, Pfizer, Karlsruhe, Germany), ivermectin as a 1% injectable formulation (Ivomec[®], MSD-Agvet, Grünwald, Germany), moxidectin as a 0.1% drench formulation for sheep (Cydectin[®], American Cyanamid Company, New York, USA), albendazole as a 10% drench formulation for cattle (Valbazen[®], Smith Kline Beecham, München, Germany), fenbendazole as a 18.75% paste formulation for horses (Panacur[®] Paste, Hoechst Veterinär, Unterschleissheim, Germany) and flubendazole as a 4.4% gel formulation for dogs and cats (Flubenol[®] P, Janssen Pharmaceutica, Neuss, Germany). Pyrantel embonate (20 mg base kg⁻¹ bodyweight (bwt.)), ivermectin (1 mg kg⁻¹ bwt.) and moxidectin (1 mg kg⁻¹ bwt.) were given once; albendazole (50 mg kg⁻¹ bwt. day⁻¹), fenbendazole (50 mg kg⁻¹ bwt. day⁻¹) and flubendazole (22 mg kg⁻¹ bwt. day⁻¹) were administered once daily for three consecutive days. The doses of the liquid and paste formulations were measured using a calibrated syringe or weighed, respectively, to ensure accurate dosage, then mixed with small amounts of moist cat food and fed to the raccoons.

The efficacy of each anthelmintic compound was estimated in terms of critical tests (Jacobs et al., 1994). Subsequent to (first) treatment, all faeces passed were collected daily until necropsy and washed in a 150 μ m mesh screen. The material retained in the screen was examined under low magnification for expelled roundworms. Animals were killed and necropsied 7 days after the last day of treatment. The gastrointestinal tract was opened, and the contents were passed through a 150 μ m mesh screen and then examined for *B. procyonis* stages. All adult and immature worms removed from any source were counted and identified as to species. Efficacy was determined by comparing the number of roundworms passed with the total worm burden (number passed plus number found at necropsy). Statistical analysis was conducted assuming a negative binomial distribution of worm counts. The mean percentage reduction of worm burdens was calculated as well as the lower confidence limit at 95% level for this estimate.

Table 1

Numbers of *Baylisascaris procyonis* (adult and immature stages) passed with the faeces of naturally infected raccoons after anthelmintic treatment via food and recovered at necropsy 7 days after treatment, and anthelmintic efficacy in terms of critical tests; seven raccoons per treatment group

Anthelmintic compound	Treatment days × dosage (mg kg ⁻¹)	No. of worms passed by each raccoon	No. of worms recovered	Efficacy (%)
Pyrantel embonate	1 × 20 ^a	1, 1, 2, 5, 23, 25, 198	0	100
Ivermectin	1 × 1	2, 3, 5, 7, 9, 11, 24	0	100
Moxidectin	1 × 1	2, 2, 3, 6, 7, 10, 14	0	100
Albendazole	3 × 50	3, 4, 4, 15, 34, 57, 80	0	100
Fenbendazole	3 × 50	2, 2, 17, 19, 25, 37, 70	0	100
Flubendazole	3 × 22	2, 5, 5, 6, 17, 24, 35	0	100

^aReferring to pyrantel base.

3. Results

All raccoons consumed the medicated food within 1 h. Vomiting or any other abnormal conditions which could be attributed to the treatments was not observed in any animal. All raccoons passed one or more roundworms with the faeces. Table 1 lists the numbers passed after treatment and recovered at necropsy of the animals. No roundworm was found in any raccoon at the post mortem examinations, resulting in a 100% efficacy of each compound; the lower 95% confidence limit of the efficacy was 62.5% owing to the rather limited number of animals used.

4. Discussion

This paper presents results on the oral efficacy of six anthelmintics against natural roundworm infections in raccoons. Considering that oral treatment with anthelmintics will be the most practicable route of administration in raccoons, all tested drugs were given via food. Among available anthelmintic formulations, we selected those with a high concentration of the respective active ingredient to avoid a reduced palatability owing to high drug volumes mixed with the food. Dose regimens of pyrantel embonate (Reinemeyer and DeNovo, 1990; Ridley et al., 1991), albendazole (Theodorides et al., 1976), fenbendazole (Roberson and Burke, 1980, 1982) and flubendazole (Vanparijs et al., 1985), known to be highly effective against ascarids in dogs or cats, were chosen for use in raccoons in the present trials. Ivermectin when given intramuscularly at a dosage of 2 mg kg⁻¹ bwt. failed to suppress the shedding of *B. procyonis* eggs in one of ten raccoons in a recent study (Hill et al., 1991); it was also not completely effective against *Toxocara* and *Toxascaris* infections in dogs at an s.c. dosage of 0.4 mg kg⁻¹ bwt. (Anderson and Roberson, 1982). Moxidectin showed only 'some activity' against canine ascarids at oral dose rates of up to 0.3 mg (Supakorndej et al., 1993). An oral dose rate of 1 mg kg⁻¹ bwt. of both macrocyclic lactones was therefore tested in the present trials.

Test animals which were captured over a 20 month period varied in sex and age; these variations may explain the differences in individual worm burdens resulting, for example, in a total of 44 and 255 *B. procyonis* stages in the moxidectin and pyrantel group, respectively.

Spontaneous expulsion of some or all roundworms was observed in two of nine untreated raccoons kept for other reasons for a longer period under similar conditions to those in the present study (C. Bauer, unpublished data, 1991–1992). It is possible that this phenomenon occurred to a certain extent also in treated raccoons of the present study and thus influenced the estimation of efficacy. Nevertheless, all tested anthelmintics provided the necessary 100% control of *B. procyonis* infections.

If raccoons are kept as pet animals or in captivity, preventive measures are indispensable to diminish the risk of transmission of *B. procyonis* to humans and domestic animals. Newly captured raccoons should be put in quarantine and dewormed. On the basis that the prepatent period of *B. procyonis* is at least 32 days (Kazacos and Boyce, 1989), repeated anthelmintic treatments at not more than monthly intervals should prevent environmental contamination with eggs. In conclusion, the results of the present study suggest that pyrantel embonate, ivermectin, moxidectin, albendazole, fenbendazole or flubendazole, when administered orally at the dose regimens tested, can be used in such control programmes. All compounds were well tolerated.

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