Strategic control of gastrointestinal nematodes of sheep in the highlands of central Kenya

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ABSTRACT

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The effectiveness of anthelmintic treatments given 3 weeks after the onset of rains to control gastrointestinal nematodes in sheep in the highlands of central Kenya was investigated. The study was carried out on a farm situated approximately 85 km north west of Nairobi in Nyandarua District of central Kenya. In May 1999, 35 Corriedale ram lambs aged between 8 and 10 months were ear-tagged, weighed and given albendazole at 3.8 mg/kg body mass. The animals were then allocated to three treatment groups.

Three weeks after onset of both the short and long rains' season in November 1999 and April 2000 respectively, lambs in groups 1 and 2 were dewormed. Lambs in group 1 were given closantel at 10 mg/kg body mass in November and closantel plus albendazole at 3.8 mg/kg body mass in April. Lambs in group 2 were given albendazole at 3.8 mg/kg body mass on both occasions, while lambs in group 3 were maintained as the untreated controls. Nematode eggs per gram of faeces (epg) for lambs in the control group were significantly higher ($P < 0.05$) than in the treated groups beginning from November, when the strategic treatments started. The levels of epg did not differ significantly between the two treated groups. Body mass for the treated groups was significantly higher ($P < 0.05$) than for the control group from January 2000 until the experiment was terminated. The rainfall received in the study area in 2000 during the long rain season was inadequate and only occurred for a short period. The amount of herbage on pastures was therefore not adequate and all the study animals started losing mass from June 2000 until the experiment was terminated. The cumulative mass gain and amount of wool produced by the treated lambs during the study period did not differ significantly. There was therefore no difference in using either of the two drugs. It is concluded that, strategic anthelmintic treatments of sheep at the start of the wet season in the highlands of central Kenya is effective in controlling gastrointestinal nematodes. To prevent high levels of re-infection during the season of the long rains (April to June), it is recommended that, during this season, a second treatment be given 5–6 weeks after the first one or at the start of the dry season.

Keywords: Albendazole, closantel, control, gastrointestinal nematodes, Kenya highlands, sheep

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INTRODUCTION

Gastrointestinal (GIT) nematodes are an important constraint to improved production of small ruminants in all ecological zones of Kenya (Carles 1993; Wanyangu & Bain 1994; Gatongi, Scott, Ranjans, Gathuma, Munyua, Cheruiyot & Prichard 1997; Githigia, Thamsborg, Munyua & Maingi 2001). Control of these parasites in ruminants in the country is based primarily on the use of a wide range of anthelmintics (Kinoti, Maingi & Coles 1994; Maingi, Bjørn, Thamsborg, Munyua, Gathuma & Dangolla 1997a). The most effective strategies to control the parasites using anthelmintics are usually those based on a thorough knowledge of the species of parasites present, their seasonal availability and of the weather conditions in a particular area (Brunsdon 1980). Results from studies on the epidemiology of GIT nematode infections of sheep in the high rainfall highlands of central Kenya (Maingi, Gichohi, Munyua, Gathuma & Thamsborg 1997b), showed that *Haemonchus contortus* is the most common nematode, and that pasture infectivity and worm burdens in sheep in this area are high during the rainy seasons, of which there are two per year, viz. the long rains from April to June and the short rains from November to December. During the intervening dry seasons, the parasite population is maintained both on pasture and in the animals without undergoing hypobiosis. In addition, these results showed that strategic anthelmintic treatments during the rainy seasons would be effective in controlling GIT nematodes of sheep in the area. In a follow-up study in this area, the treatment of sheep with closantel plus albendazole at the start of the long rains in April, end of the long and short rains in June and December respectively, and during the intervening dry season in August was found to be effective in controlling GIT nematodes (Maingi, Thamsborg, Gichohi, Munyua & Gathuma 1997c). The number of anthelmintic treatments used in the trial, however, was high and such a strategy, where both closantel and albendazole are frequently used, would be too expensive for the majority of farmers in the area. Further trials to determine the effectiveness of anthelmintic treatments given during the wet season only should therefore be conducted (Maingi *et al.* 1997c).

Closantel, a narrow-spectrum salicylanilide is effective against blood-sucking helminth parasites, such as *Fasciola* and *Haemonchus*, when administered at 10 mg/kg body mass. At this dose rate, the drug also provides up to 99% protection against re-infection with *Haemonchus* for 30 days post-treatment and up to 63% protection for an additional 30 days (Hall, Kelly, Whitlock & Ritchie 1981). The drug is therefore suitable for use in high-rainfall tropical regions such, as the Nyandarua District in Kenya, where conditions are favourable for development of infective larvae for long periods during a year. The majority of farmers in this area, however, use levamisole and benzimidazoles, such as albendazole, which are readily available. Albendazole when administered at 3.8 mg/kg body mass in sheep, is effective against most roundworms including *H. contortus* and *Trichostrongylus* spp. for about 24 h, but has no residual effect against newly acquired larvae (Behm & Bryant 1985; Campbell 1990). No previous studies have been carried out to investigate the effectiveness of the strategic use of albendazole on its own for the control of GIT nematodes in sheep in the central highlands of Kenya.

The objective of this study was to compare the faecal nematode egg counts and performance of lambs on pasture in Nyandarua District, when dewormed during the rainy seasons with either albendazole or closantel plus albendazole to control naturally acquired GIT nematodes.

MATERIALS AND METHODS

This study was carried out on a farm located approximately 85 km north-west of Nairobi in the Kinangop division of Nyandarua District in the central highlands of Kenya. The farm is at an altitude of approximately 2 000 m above sea level. The area has a cool and wet climate and receives a mean annual rainfall of between 1700 and 2000 mm. The rainfall is bimodal, April to June (long rains) and October to December (short rains). The mean minimum monthly air temperature varies from 6–10 °C, while the mean maximum temperature varies from 22–26 °C. This climate is conducive for the transmission of GIT nematodes throughout most of the year.

The farm was a 60 ha arable, and a sheep-and-cattle-rearing enterprise. The main type of grass on the pastures was kikuyu grass (*Pennisetum clandestinum*). Sheep had been reared on the farm for about 15 years and both benzimidazoles and levamisole groups of anthelmintics had been used at one time or another during the preceding 15 years. Oxyclosanide was used regularly on the farm to control *Fasciola* infections.

Study design

Table 1 shows the groups and numbers of lambs used in the study, the time of anthelmintic treatments and the types and dosages of anthelmintics used.

In May 1999, 35 Corriedale ram lambs aged between 8 and 10 months and ranging in body mass between 20 and 26 kg were ear-tagged, weighed and drenched with albendazole (Valbazen® Novartis East Africa Ltd., Nairobi) at 3.8 mg/kg body mass. They were then randomly allocated into three

TABLE 1 The groups and numbers of lambs used in the study, the time of anthelmintic treatments and the types and dosage of anthelmintics used

Group	No. of lambs	Time of treatment	Anthelmintic used and dosage
1	12	May 1999 November 1999 April 2000 Every 9 weeks from May 1999	Albendazole, 3.8 mg/kg Closantel, 10 mg/kg Closantel, 10 mg/kg plus Albendazole, 3.8 mg/kg Triclabendazole, 10 mg/kg
2	12	May and November 1999 and April 2000 Every 9 weeks from May 1999	Albendazole, 3.8 mg/kg Triclabendazole, 10 mg/kg
3	11	May 1999 Every 9 weeks from May 1999	Albendazole, 3.8 mg/kg Triclabendazole, 10 mg/kg

groups of 12, 12 and 11 lambs and allowed to continue grazing together on a 2.5 ha paddock for 1 month. Examination of herbage samples collected from the paddock at this time revealed that it was contaminated with infective larvae *of Haemonchus* (65 %), *Trichostrongylus* (25 %), *Oesophagostomum* (5 %) and *Cooperia* (5 %), at a level of 900 larvae per kilogram of dry herbage. In June 1999, the paddock was subdivided by wire fencing into three equal parts and the three groups of lambs randomly assigned to the three sub-plots. The lambs were set-stocked on the sub-plots for the 14 months duration of the study. Their feed was supplemented with minerals in the form of mineral blocks (Maclik®, Coopers, Nairobi) and an *ad libitum* supply of tap water was provided. Fasciolosis is a common problem in the study area and prophylactic treatment with triclabendazole (Fasinex®, Novartis East Africa Ltd., Nairobi) was given every 9 weeks at 10 mg/kg body mass to all the animals during the entire period of the study.

Three weeks after the onset of the short rains in November 1999, lambs in group 1 were dewormed with closantel (Flukiver®, Janssen Pharmaceutica, Belgium) at 10 mg/kg body mass. At the same time, lambs in group 2 were given albendazole (Valbazen®, Novartis East Africa Ltd., Nairobi) at 3.8 mg/kg body mass. Three weeks after the onset of the long rains in April 2000, lambs in group 1 were dewormed with closantel at 10 mg/kg and albendazole at 3.8 mg/kg body mass while those in group 2 were given albendazole alone at 3.8 mg/kg body mass. Lambs in group 3 (control group) remained untreated, except for the salvage treatment with albendazole given to two lambs when strongylid-type eggs reached 2000 per gram of faeces on two consecutive sampling occasions. The treated lambs were subsequently removed from the experiment.

Sampling and analysis

Rectal faecal samples were collected from all lambs in the experiment every 3 weeks. The strongylid-type nematode eggs per gram of faeces (epg) were determined for individual sheep using the McMaster technique (Whitlock 1948) with a lower limit of detection of 100 epg. When the faecal samples for any of the three groups were positive for nematode eggs, the samples were pooled for each group and cultured at 27 °C for a period of 10 days. Larvae isolated from the cultures were identified by their cuticular morphology and size as described in the MAFF manual (MAFF 1986). All the lambs were weighed every 3 weeks. At the start and end of the study, all the lambs were shorn and the amount of wool produced by each lamb during the study period determined. The amount of rainfall received in the area during the study period and the long-term monthly average rainfall data were obtained from a meteorological station situated approximately 4 km from the farm.

Statistical analysis

Faecal strongyle egg counts were log transformed [log10 (x + 10)] to normalize their distribution. Egg counts and body mass were then compared between the groups by the repeated measures analysis of variance (ANOVA) using the general linear models (GLM) procedure (Anon. 1990), with pair-wise comparisons between the groups.

RESULTS

The total monthly rainfall recorded in the study area during the period May 1999 to August 2000 and the long-term (40 years) mean total monthly rainfall for the area are shown in Fig. 1. November and De-

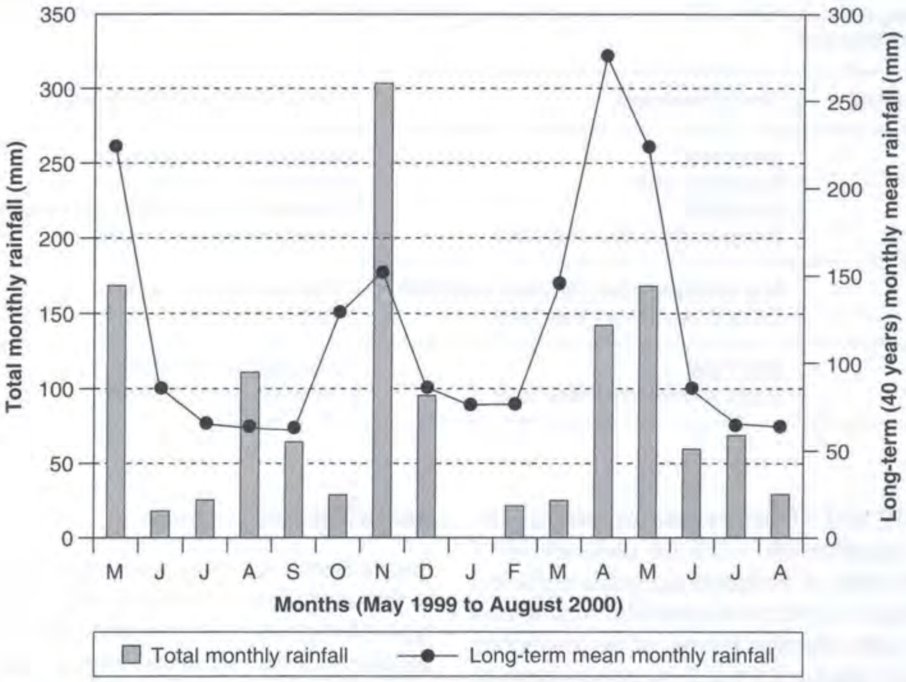

FIG. 1 The total monthly rainfall in mm (vertical bars) recorded in Kinangop division of Nyandarua District during the period May 1999 to August 2000 and the long-term (40 years) mean monthly rainfall (line) for the area

cember 1999, and April to July 2000 fell within the seasons of the short and long rains, respectively. There was a shortfall in the amount and duration of the rains received during the long rainy season in 2000, when compared to the long-term average for the area. This resulted in a drought, with very poor growth of pasture on the study plots.

In Fig. 2 the arithmetic mean strongylid epg for the three groups of lambs every 3 weeks, beginning in May 1999 and ending in August 2000, is shown.

Nematode epg for all three groups dropped to zero after the first treatment with albendazole in May 1999. The mean epg then gradually increased to a maximum of 2 400, 2 550 and 2 250 in groups 1, 2 and 3, respectively, in November 1999, when the short rainy season started and the strategic anthelmintic treatments were given to the lambs in groups 1 and 2. From this time onwards, the epg for the untreated control lambs remained higher than those of the treated groups. This difference was statistically significant during all sampling occasions except in April 2000. The drop in mean epg for lambs in the control group observed in January and February, and again in April, was because of the removal of the two lambs from this group, that were treated in December and March, because of their very high epg counts. Although the mean epg for the closantel-treated lambs (group 1) decreased significantly in November 1999 when the drug was used alone, the epg did not drop to zero. After the following two sampling occasions, however, and when closantel was used in combination with albendazole in April 2000, the mean epg for this group remained lower than that of the albendazole-treated group soon after each treatment. This difference was not statistically significant.

The arithmetic mean body mass for all three groups of lambs is shown in Fig. 3.

The mean body mass of all three groups of lambs were similar up to November 1999 when the anthelmintic treatments were given to lambs in groups 1 and 2. The mean body mass for the treated groups remained similar and significantly higher than that of the control group up to August 2000, when the experiment was terminated. From June 2000 all animals began to lose mass because of the drought experienced during that year.

Haemonchus contortus followed by *Trichostrongylus* spp. predominated in the faecal cultures from lambs in all the groups throughout the study period, except in December 1999 and January and February 2000 when only *Trichostrongylus* spp. and *Oesophagostomum* spp. were found in faecal cultures from lambs in group 1.

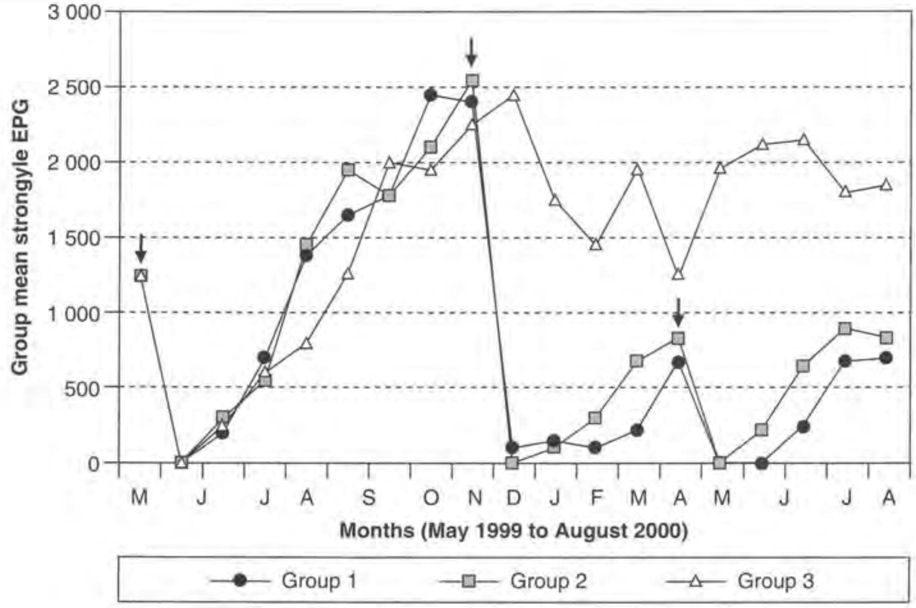

FIG. 2 The arithmetic mean faecal strongyle eggs per gram of faeces (epg) recorded every 3 weeks starting from May 1999 to August 2000 for groups of lambs strategically dewormed with either closantel (group 1) or albendazole (group 2) and an untreated control (group 3). The arrows indicate the months when the anthelmintic treatments were given

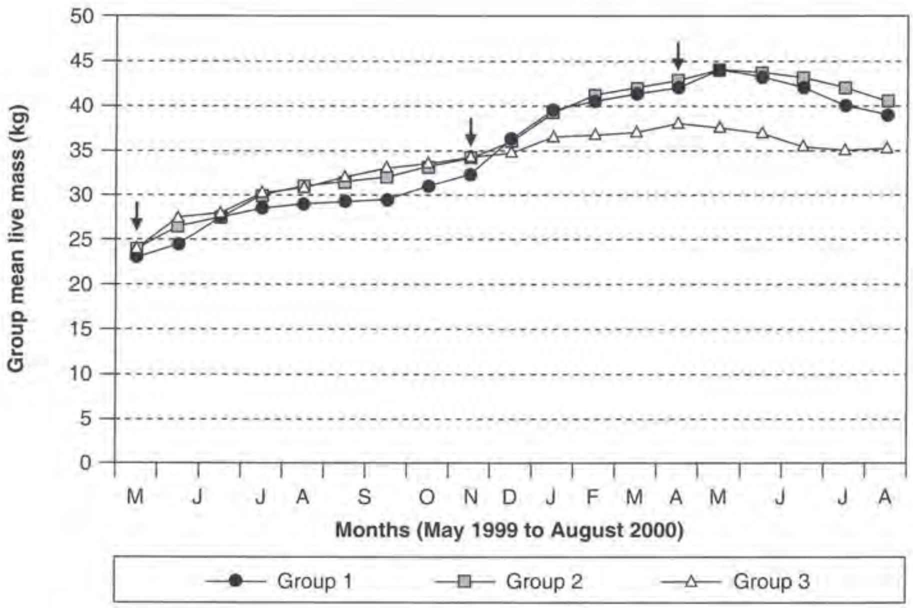

FIG. 3 The arithmetic mean body mass recorded every 3 weeks starting from May 1999 to August 2000 for groups of lambs strategically dewormed with either closantel (group 1) or albendazole (group 2) and an untreated control (group 3). The arrows indicate the months when the anthelmintic treatments were given

The amount of wool produced during the trial period by the lambs in the group that were treated with closantel was 38.5 kg (mean per animal, 4.3 $\pm$ 0.54), that produced by the albendazole treated group 35.5 kg (mean per animal, 4.44 $\pm$ 0.6) and that by the control group 32.5 kg (mean per animal, 3.79 $\pm$ 0.4). The differences in wool production among the groups of lambs were not statistically significant.

DISCUSSION

Results from this study indicate that the strategic use of closantel or albendazole at the start of the rainy seasons in the highlands of central Kenya is effective in reducing the worm burdens in sheep, as evidenced by the decrease in epg in the treated lambs. This reduction in worm burdens resulted in improved mass gain in the treated groups of lambs, compared to those in the untreated group. This observation supports the conclusions of others (Allonby & Urquhart 1975; Carles 1993; Wanyangu & Bain 1994; Gatongi *et al.* 1997; Githigia *et al.* 2001) that GIT nematodes are an important cause of lowered productivity and ill health in small ruminants in Kenya. Although losses due to these parasites may not be as severe as those due to acute infectious diseases, the overall loss due to helminthosis is arguably much greater (Donald 1979). Compared with the generally temporary nature of outbreaks of acute diseases, where surviving animals often recover rapidly, nearly all animals are infected with helminths most of the time, and acquisition of larvae from pasture can be more or less continuous (Waller 1991).

One way of keeping worm burdens at a minimum level and of improving productivity of grazing livestock is through regular use of anthelmintics (Brunsdon 1980). The most effective strategies to control these parasites using anthelmintics are usually those based on a thorough knowledge of the species of parasites present, their seasonal availability and of the weather conditions in a particular area (Brunsdon 1980). The anthelmintic treatments given in this study were based on previous studies on the epidemiology of helminth infections in sheep in the study area (Maingi *et al.* 1997b). Because of the high levels of pasture infectivity and worm burdens in sheep during the rainy seasons in this area, Maingi *et al.* (1997b) recommended that animals be dewormed soon after the onset of rains. During the intervening dry season, the levels of infection in the sheep should be monitored and animals dewormed when necessary. The results obtained in the present study indicate that strategic wet-season deworming in the area is effective. In spite of the poor amount of rainfall and brevity of duration of the long rains in 2000, nematode epg started rising in June and had reached high levels by August 2000 although the animals had been dewormed in April. A similar trend was obtained from June to November 1999 after the lambs were dewormed in May. In normal long rains, when weather conditions are more favourable for nematode transmission, a second treatment 5–6 weeks after the first one in April (start of rains), or a treatment given towards the end of the rainy season in June may be necessary. Anthelmintic treatments for all animals in a flock during the dry season should be discouraged, but individual animals may be treated based on the level of faecal nematode epg or the level of anaemia determined using the novel FAMACHA® System (Malan, Van Wyk & Wessels 2001) recently developed in South Africa.

Results from this study also indicate that there was no significant advantage of using closantel over albendazole although the former has a residual effect against both adult parasites and newly acquired larvae of *H. contortus* (Hall *et al.* 1981). On the other hand, albendazole when administered at 3.8 mg/kg body mass in sheep, is effective against most roundworms including *H. contortus* and *Trichostrongylus* spp. for about 24 h, but has no extended effect against newly acquired larvae (Behm & Bryant 1985; Campbell 1990). Faecal cultures prepared from the study sheep revealed that *H. contortus* followed by *Trichostrongylus* spp. predominated in all the groups throughout the study period. *Haemonchus contortus* is regarded as the most important nematode in small ruminants in Kenya (Carles 1993; Wanyangu & Bain 1994), and it is against this species that worm control is primarily targeted. The treated animals therefore performed better than those that were not treated. The combined closantel plus albendazole treatments given at the beginning of the long rains for group 1 was aimed at minimizing infection with other nematodes such as the *Trichostrongylus* spp. which are not eliminated by closantel. These nematodes were responsible for the egg counts observed in November and December 1999 in group 1 after treatment with closantel alone. *Trichostrongylus* spp. (80 %) and *Oesophagostomum* spp. (20 %) were the only larvae observed in faecal cultures from group 1 during this period. In a strategic deworming programme where closantel is used, occasional treatments with a broad-spectrum anthelmintic may be necessary to prevent build-up of infection with other nematodes.

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