Effects of Three Anthelmintic Treatment Regimes against *Fasciola* and Nematodes on the Performance of Ewes and Lambs on Pasture in the Highlands of Kenya

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ABSTRACT

The efficacy of strategic anthelmintic control of liver flukes (*Fasciola*) and gastrointestinal (GI) nematodes on the performance of ewes and lambs on pasture was assessed on a farm in the highlands of Kenya. In May 1999, 45 Corriedale ewes, aged between 2 and 3 years, were ear-tagged, weighed and allocated randomly to three equal treatment groups based on body weight. Faecal samples taken at this time revealed low levels of strongyle-type eggs per gram of faeces (EPG) and the presence of liver fluke eggs in only a few of the animals. All the animals were then set stocked for 12 months on separate paddocks in an area endemic for both *Fasciola* and GI nematodes. The ewes in group 1 were given a combined anthelmintic treatment against *Fasciola* and GI nematodes during the periods recommended for the control of *Fasciola* in the area (February, June and October). The ewes in group 2 were given the combined treatments 3 weeks after the onset of both the short and long rainy seasons (November and April, respectively). Those in group 3 were given separate treatments for *Fasciola* (February, June and October) and nematodes (3 weeks after the onset of the rainy seasons). The anthelmintic treatment against *Fasciola* consisted of triclabendazole at 10 mg per kg body weight, and that against nematodes was levamisole at 10 mg per kg body weight.

The nematode EPG for the ewes in group 1 were higher than in groups 2 and 3 during both rainy seasons. The nematode EPG did not differ significantly between groups 2 and 3. The prevalence of *Fasciola* eggs (number of ewes shedding eggs in a group) in the ewes in groups 1 and 3 remained very low throughout the study period compared to those in group 2. The highest birth weights and the weight gains of lambs were recorded for the group of ewes given separate anthelmintic treatments for *Fasciola* and nematodes (group 3). The results of this trial indicated that, in an area like Nyandarua District, where liver flukes and GI nematodes are important constraints to sheep production, the best practice is to give separate treatments for the two groups of parasites at the recommended times.

Keywords: anthelmintic, *Fasciola*, gastrointestinal nematodes, live weight, management, season, sheep, strategic control

Abbreviations: EPG, eggs per gram; GI, gastrointestinal
INTRODUCTION

Ruminants play an important role in the agricultural sector in Kenya, contributing approximately 20% of the total agricultural production (Anonymous, 1986a). Improving the health and productivity of such livestock therefore offers an excellent opportunity to feed a rapidly increasing human population (Anonymous, 1986a). Losses in the country due to diseases in ruminants are estimated to be high, many of them occurring from tick-borne, viral and helminth infections (Anonymous, 1986b). The available information indicates that gastrointestinal (GI) nematodes, particularly the highly pathogenic *Haemonchus contortus*, are prevalent in sheep and goats in most parts of the country and that production and economic losses, due to both clinical and chronic subclinical infections, may be high (Allonby and Urquhart, 1975; Anonymous, 1976; Carles, 1993). Annual losses in sheep and goats due to haemonchosis alone in the country have been estimated at US$ 26 million (Anonymous, 1976). In addition to GI nematodes, liver flukes (*Fasciola gigantica*) are also prevalent and a major constraint to production in cattle, sheep and goats, particularly in the areas of high agricultural potential, which also receive a high rainfall and have a high livestock density (Anonymous, 1986b; Bitakaramere, 1969). Subclinical or chronic fasciolosis is the most common form of the disease in Kenya (Bitakaramere, 1969). In 1986, annual losses due to fasciolosis in cattle, sheep and goats in the country were estimated at approximately US$ 6 million (Anonymous, 1986b). Control of both parasites is, therefore, necessary to improve the health and productivity of ruminants.

Control of both GI nematodes and liver flukes in ruminants in Kenya is based primarily on the use of anthelmintics (Kinoti et al., 1994; Maingi et al., 1997a). Optimal control of these parasites using anthelmintics needs to be based on the parasites' epidemiology, with treatments being given to prevent pasture contamination and host infection (Brunsdon, 1980; Nansen, 1991). Previous studies on the epidemiology of GI nematodes in sheep in Nyandarua District (Maingi et al., 1997b) revealed that *Haemonchus* is the most prevalent nematode, and that pasture infectivity and worm burdens are highest during the rainy seasons. During the intervening dry seasons, the parasites' population is maintained both on pasture and in the animals without undergoing hypobiosis. The results from that study indicated that strategic anthelmintic treatments against GI nematodes should be given during the rainy seasons. In the tropics, the critical infection period for liver flukes, on the other hand, is during the dry period following the end of the rains (Anonymous, 1986b, 1999). Based on abattoir surveys in Kenya, it has been established that peaks of prevalence of *Fasciola* always occur 1–2 months after the peak of the rains (Anonymous, 1986b). The Food and Agriculture Organization has therefore recommended that animals in the highlands of Kenya be treated in the middle of the dry season in February, at the end of the long rainy season in June and in the late dry season in October (Anonymous, 1999).

In areas of Kenya where both GI nematodes and liver flukes are a serious cause of mortality and reduced productivity in ruminants, such as Nyandarua District (Anonymous, 1986b; Maingi et al., 1997b), and because of the difference in the epidemiology of the two groups of parasites, farmers are faced with the problem of controlling both these parasites. Previous studies in the district have shown that the
most common practice is to use a single anthelmintic or combined anthelmintic products that remove both GI nematodes and liver flukes at the same time (Maingi et al., 1997a). These drugs are normally given at an interval of approximately 3 months or during the wet season, when nematode infections are likely to be the major problem (Maingi et al., 1997a). The practice of using such combined anthelmintic products is convenient for farmers, but information on their efficacy in controlling both GI nematodes and liver flukes, when they are applied at the same time, is lacking. The objective of the present study was therefore to determine the efficacy of combined and separate strategic anthelmintic control of liver flukes and GI nematodes on the performance of ewes and lambs on pastures in Nyandarua District in the highlands of central Kenya.

MATERIALS AND METHODS

The study was carried out on a farm located approximately 85 km northwest of Nairobi, in Nyandarua District in the central highlands of Kenya, at an altitude of approximately 2000 m above sea level. The area has a cool, wet climate, and receives a mean annual rainfall of between 1700 and 2000 mm. The rainfall is bimodal, March to June (long rains) and October to December (short rains). The mean minimum monthly air temperature varies from 6° to 10°C, while the mean maximum temperature varies from 22° to 26°C. The climate is conducive for transmission of GI nematodes almost throughout the year, and the prevalence of Fasciola gigantica is approximately 40% in both cattle and sheep (Anonymous, 1986b). Mortalities of up to 55% due to acute fasciolasis in sheep have also been recorded on individual farms in the district during the dry season (Maingi and Mathenge, 1995).

The farm was a 60 ha, arable and sheep- and cattle-rearing enterprise. Sheep had been reared on the farm for approximately 15 years and both the benzimidazole and levamisole groups of anthelmintics had been used to control GI nematodes on the farm at one time or another. Triclabendazole and nitroxinil had also been used to control fasciolasis in cattle and sheep.

Study design

In May 1999, 45 Corriedale ewes aged between 2 and 3 years were ear-tagged, weighed and allocated to three treatment groups of 15 ewes each, based on their body weights, so as to ensure uniformity of live weights across the groups. Faecal samples taken at this time revealed low levels of strongyle-type nematode eggs per gram of faeces (EPG) and the presence of liver fluke eggs in only a few animals. All the ewes were then set stocked for 12 months on separate paddocks that were endemic for both Fasciola and GI nematodes. All the ewes were mated only once in November 1999. The ewes in group 1 were given a combined anthelmintic treatment against Fasciola and GI nematodes during the periods recommended by FAO (Anonymous, 1999) for the control of Fasciola in the highlands of Kenya, that is in February, June and October.
The combined treatment consisted of levamisole (Wormicid, Cosmos, Nairobi, Kenya) against nematodes, at 10 mg/kg body weight and triclabendazole (Fasinex, Novartis Animal Health, Johannesburg, South Africa) against *Fasciola*, at 10 mg/kg body weight. The ewes in group 2 were given the same combined treatment 3 weeks after the onset of both the short and long rainy seasons (November 1999 and April 2000, respectively). Those in group 3 were given separate treatments with triclabendazole at 10 mg/kg body weight to control *Fasciola* in June and October 1999 and February and June 2000, and levamisole at 10 mg/kg body weight, 3 weeks after the onset of the rainy seasons, to control nematodes.

**Sampling and analysis**

Rectal faecal samples were collected from all the experimental ewes every 3 weeks. The strongyle-type nematode EPG was determined for individual sheep by the modified McMaster technique (Whitlock, 1948), with a lower limit of detection of 100 eggs per gram of faeces. The faecal samples were also examined for the presence of *Fasciola* eggs using a sedimentation technique described in the MAFF manual (MAFF, 1986). The ewes started lambing in April 2000 and the lambing rate, birth weights and weight gains for lambs were recorded during the rest of the study. The rainfall received in the area during this period and the long-term monthly average rainfall data were obtained from a meteorological station situated approximately 4 km from the study farm.

**Statistical analysis**

Faecal strongyle-type nematode egg counts were log transformed (log \((10(x+10))\)) to normalize their distribution. The egg counts were then compared between the groups by the repeated measures analysis of variance (ANOVA) using the general linear models (GLM) procedure (Anonymous, 1990), with pairwise comparisons between the groups. Birth weights and weight gains for the lambs were compared between the groups using ANOVA. Lambing rates were compared between the treatment groups using the \(\chi^2\) test; \(p\) values \(\leq 0.05\) were considered significant.

**RESULTS**

The monthly total rainfalls recorded in the study area during the study period (May 1999 to August 2000) and the long-term (40 years) mean total monthly rainfall for the area are shown in Figure 1. November and December 1999 and April to July 2000 were the short and long rainy seasons, respectively. There was a shortfall in the amount and duration of the rains received during the long rainy season when compared to the long-term average for the area.

The arithmetic mean strongyle-type nematode EPG for the three groups of ewes determined every 3 weeks starting from May 1999 to August 2000 are shown in Figure 2. All the animals had been dewormed in April 1999, and the nematode EPGs in all
Figure 1. The monthly total rainfalls in millimetres (vertical bars), recorded in Kinangop division of Nyandarua District, during the period May 1999 to August 2000, and the long-term (40-year) mean monthly total rainfalls (curve) for the area.
Figure 2. The arithmetic mean faecal strongyle-type nematode eggs per gram of faeces (EPG) recorded every 3 weeks from May 1999 to August 2000 for the ewes in group 1 (●) (treated with levamisole to remove GI nematodes in June and October 1999 and February and June 2000) and group 2 (■) and group 3 (△) (given similar treatments 3 weeks after onset of the rainy seasons in November 1999 and April 2000). The arrows with a single line indicate the times of treatment for the ewes in group 1; the solid black arrows indicate the times of treatment for ewes in group 2; and the open white arrows indicate when ewes in group 3 were treated.

Three groups were therefore low at the beginning of the study. The nematode EPG for group 2 (treatment during the rainy season) and group 3 (separate treatments for Fasciola and GI nematodes) then rose gradually during the dry season from June to November 1999, when the first anthelmintic treatment against GI nematodes was given. After this treatment, the nematode EPG for these two groups remained low during the dry season from December 1999 to March 2000. The second anthelmintic treatment at the beginning of the long rainy season in April 2000 reduced the nematode EPG in the two groups to zero but the animals became re-infected soon after, and the nematode EPG started to rise gradually from June until the experiment was terminated in August 2000. The nematode EPG for the ewes in group 1 (treatment in June and October 1999 and February and June 2000) remained low during the dry season from June to September 1999, when the two other groups had high nematode egg counts. The treatment in October 1999 and February 2000 effectively reduced the nematode egg counts to zero in this group. However, the animals soon became re-infected with
Figure 3. The percentage of ewes shedding *Fasciola* eggs in faeces recorded every 3 weeks starting from May 1999 to August 2000 for ewes in group 1 (grey bars) and group 3 (black bars) (treated with triclabendazole to remove *Fasciola* in June and October 1999 and February and June 2000) and in group 2 (white bars) (given the same treatment 3 weeks after the onset of the rainy seasons in November 1999 and April 2000). The grey, black and white arrows indicate the times of treatment for the ewes in the groups with corresponding bars.
GI nematodes during the short and long rainy seasons in November 1999 and April 2000, respectively. This resulted in high nematode EPG from December 1999 to February 2000 again in May and June 2000. During these periods, the nematode infections in the other two groups (groups 2 and 3) were well controlled and significantly lower ($p < 0.05$) than in group 1.

The percentage of animals that were shedding liver fluke eggs in each of the three groups of ewes is shown in Figure 3. At the beginning of the study, in May 1999, only a small percentage (3 out of 45) of the ewes in the flock were shedding liver fluke eggs. The percentages of ewes shedding liver fluke eggs in each of the three groups then rose gradually to reach a maximum of 67% (10 out of 15) in group 2 (treatment during the rainy season) in October 1999. During this period, the ewes in this group were also heavily infected with GI nematodes, as indicated by the high EPG in Figure 2. The percentage of ewes shedding liver fluke eggs in groups 1 and 3 remained similar throughout the study period. The anthelminthic treatments given in June 1999 to the ewes in groups 1 and 3 significantly reduced the percentage of animals shedding liver fluke eggs, which then remained lower than those in group 2 throughout the dry season from June to November 1999. A similar effect was observed after the anthelminthic treatment in February 2000. However, a higher percentage of ewes in groups 1 and 3 were shedding liver fluke eggs, compared to those in group 2, in May and June 2000.

The lambing rates in groups 1, 2 and 3 were 93% (14 out of 15), 67% (10 out of 15) and 87% (13 out of 15), respectively. Lambing rates for ewes in groups 1 and 3 did not differ significantly, but were significantly higher ($p < 0.05$) than the lambing rate in group 2. All the lambs were born alive and there were no abortions. The mean birth weight ($\pm$ SD) of the lambs in groups 1, 2 and 3 were 3.2 $\pm$ 0.17 kg, 2.5 $\pm$ 0.11 kg and 3.4 $\pm$ 0.32 kg, respectively. The birth weights of the lambs from ewes in groups 1 and 3 did not differ significantly, but they were significantly higher ($p < 0.05$) than the weights of those from ewes in group 2. When the experiment was terminated, the lambs in groups 1, 2 and 3 had mean body weight gains of 8.8 $\pm$ 0.5 kg, 8.5 $\pm$ 0.8 kg and 9.1 $\pm$ 0.7 kg, respectively. The weight gains for the lambs did not differ significantly between the groups.

DISCUSSION

The results of this study demonstrated that grazing sheep in this area, in which liver fluke and GI nematode were endemic, resulted in infection, and that there was improved fertility in the ewes and higher birth weights and growth rates in their lambs when this was controlled. Treatment of ewes in groups 1 and 3 with triclabendazole in February, June and October, as recommended by FAO (Anonymous, 1999), resulted in very good control of infection in these animals compared to the ewes in groups 2, which were treated during the rainy seasons in April and November. Strategic anthelminthic control of liver flukes in this area should therefore be based on this strategy, as anthelminthic treatments against flukes given during the rainy seasons are unlikely to be effective. Treating the ewes against GI nematodes with levamisole given 3 weeks after the onset of the rainy seasons in November and April also resulted in good
control of GI nematodes in the ewes in groups 2 and 3, compared to those in group 1. However, the lack of anthelmintic treatment against GI nematodes towards the end of the long rainy season in June or July in the ewes in groups 2 and 3 resulted in high levels of nematode EPG compared to those in group 1. This confirmed the work of Maingi and colleagues (1997c) in sheep in the same area, which indicated that there was a buildup of GI nematode infection during the dry season, starting from May if the animals were only dewormed once at the beginning of the long rainy season. A second anthelmintic treatment given 3–5 weeks into the long rainy season or towards the end of the rainy season in June and July, so as to prevent the buildup of GI nematode infections, is therefore recommended (Maingi et al., 1997c).

The reduced lambing rate in the ewes only given treatment against liver flukes and GI nematodes during the rainy season in November (group 2) probably resulted from low fertility, possibly due to the concomitant liver fluke and GI nematode infections during the dry season from June to November 1999. Treatment of the ewes in group 1 with triclabendazole to remove liver flukes and levamisole to remove GI nematodes in June 1999 improved the ewes’ fertility rate, as shown by the higher lambing rate in this group compared to group 2. Removing only liver flukes through triclabendazole treatment in June also improved the lambing rate in group 3, but not to the same extent as removing both liver flukes and GI nematode infections. This confirmed the work of Hope-Cawdery (1976) and Khallaayoune and Stromberg (1992), which indicated an adverse effect of fasciolosis on conception and/or the establishment of the fetus. These results therefore indicate that the best strategy would be to prevent the buildup of GI nematode infections during the dry season by an anthelmintic treatment at the end of the long rainy season and also to remove liver flukes with an anthelmintic treatment in June, as was done for the ewes in group 3.

On the basis of the present results, it appears that liver fluke and GI nematode infections are of importance in breeding ewes in Nyandarua District in Kenya. Anthelmintic treatments should therefore be used to remove liver flukes and improve production in sheep, following the recommendations of FAO (Anonymous, 1999). Gastrointestinal nematode infections should also be controlled through anthelmintic treatments given 3–4 weeks after the start of both the long and short rainy seasons, and at the end of the long rainy season or early dry season. The common practice of giving combined anthelmintic treatments against liver flukes and GI nematodes during the wet season or at times recommended for control of Fasciola is less effective and should be discouraged.

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REFERENCES


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