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Short communication

Efficacy of albendazole, levamisole and ivermectin against gastro-intestinal nematodes in naturally infected goats at the National Semi-arid Resources Research Institute, Serere, Uganda

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ABSTRACT

A study was conducted between April and July, 2011 to determine and compare the efficacy of albendazole (ABZ), levamisole (LVM) and ivermectin (IVM) against gastrointestinal nematodes in naturally infected Mubende and Boer crossbred goats at the National Semi-arid Resources Research Institute in Serere, Uganda. Forty Mubende goats and 31 Boer crosses were each blocked by age and sex and randomly assigned to four groups. The first group of each breed served as the untreated control, the second was treated with albendazole (5 mg/kg BW), the third with levamisole hydrochloride and oxyclozanide (7.5 and 15 mg/kg BW) and the fourth with ivermectin (0.2 mg/kg BW). Each group included 7–11 animals. Treatments were administered with doses of goats in albendazole and ivermectin, and doses of sheep in levamisole, as recommended by the manufacturers. In the treated groups, goats received anthelmintics basing on individual weights. Fecal egg counts, expressed as eggs per gram and larval cultures were done on day zero before treatment and on day 13 after anthelmintic treatment. Efficacy for each anthelmintic was determined by the Fecal Egg Count Reduction Test (FECRT). In Mubende goats, ABZ, LVM, and IVM reduced FEC by 28.5%, 91%, and 98%, respectively. In Boer crosses, ABZ, LVM, and IVM reduced FEC by 11%, 84.88% and 78.47%, respectively. At a 95% CI, only IVM was more effective in Mubende goats than Boer crosses ($t = 2.564$, $p < 0.05$). This may indicate occurrence of anthelmintic resistance in the goat farming sector in Uganda. Further studies need to be done to clarify the state of efficacy of the commonly used anthelmintics covering different agro ecological zones and species of animals in Uganda.

1. Introduction

Goats are important in Uganda because they provide tangible benefits of regular cash income, meat, skins, manure, as well as intangible benefits of wealth accumulation, customary norms and insurance against emergencies (Semakula et al., 2010). However, gastro-intestinal nematodes are a major factor that affects goat productivity (Lapenga and Rubaire-Akiiki, 2009). Anthelmintic resistance is on the rise in many parts of the world (Ram et al., 2007; Kumsa et al., 2010). There is scarcity of information on the efficacy of commonly used anthelmintics in Uganda. The present study, therefore, aimed at determining and comparing the efficacy of albendazole, levamisole and ivermectin against gastro-intestinal nematodes in goats, which were naturally infected at a Research Institute.

2. Materials and methods

2.1. The study area

The current study was conducted at the National Semi-arid Resources Research Institute (NaSARRI), Serere,

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Table 1
Groups of goats used to determine anthelmintic efficacy.

Group	Number of goats	
	Mubende	Boer crosses
Control	9	7
Albendazole	11	8
Levamisole	9	8
Ivermectin	11	8

north-eastern Uganda. The site is found at an altitude of 1140 m above sea level and at latitude 01°40′N and longitude 33°40′E. The mean temperature ranges from 22 °C to 30 °C. Average annual rainfall is 1350 mm ranging from 1000 to 1500 mm.

2.2. Flock management

At the time of this study, the farm was stocked with about 250 goats of Boer crosses, Mubende and Small East African breeds. Kids and adult goats were grazed together on the farm land. Rotational grazing on the farm was only practiced on the basis of availability of pastures.

Five years preceding the study, the only parasite control program for the goats was drenching with anthelmintics, mainly albendazole, at an interval of three months. Ivermectin was only used to treat a few spotted clinical cases of helminthoses. All goats of different age groups are treated with anthelmintics at the same time and interval. The farm has always been managed as a closed herd, with only occasional introduction (every two years) of new breeding stock from other government and private stock farms in Uganda.

2.3. Experimental design and care of study animals

Forty Mubende (male = 15, female = 25), and 31 Boer crossbred (male = 4, female = 27) goats were purposively selected from the goat flock. The selected goats were of mixed sex and of 3 to 15 months of age. The goats from each breed were blocked into sex and age categories of 3–6, 7–10 and 11–15 months. The age of individual goats was determined from farm management records and also by use of dentition (Swize, 2000). Each goat was identified using a numbered ear tag.

Goats from each breed were allocated to four groups, by means of a randomized complete block design (Gomez and Gomez, 1984), as shown in Table 1. Individual goats were allocated to groups by simple random sampling without replacement. None of the goats received any anthelmintic two months before the start of the experiment. The goats were then infected naturally on pastures. Fecal egg counts expressed as eggs per gram and larval identification were done on day 0 before treatment, and then 13 days after treatment with anthelmintics.

3. Anthelmintic treatment

Each goat was treated with an anthelmintic according to the individual weight with a dose recommended by the manufacturers. The dose used was recommended for goats in albendazole and ivermectin, and for sheep in levamisole. The weight of each goat was determined by means of a suspendable weighing scale. The anthelmintics used were: albendazole 10% (Albendazole®-KELA N.V., 5 mg/kg body weight); levamisole hydrochloride 3% and oxyclozanide 6% (Levafas Diamond®-Norbrook; 7.5 mg levamisole hydrochloride and 15 mg oxyclozanide per kg body weight); ivermectin 1% (Kelamectin®-KELA N.V., 0.2 mg/kg body weight). Albendazole and levamisole were administered orally using calibrated syringes whereas ivermectin was administered via subcutaneous injection route with calibrated syringes and needles. Pretreatment fasting of 12 h was instituted to facilitate effectiveness of the anthelmintics administered.

3.1. Assessment of efficacy of the anthelmintics

3.1.1. Collection and handling of fecal samples

Rectal fecal samples were collected on day zero before treatment and then day 13 after treatment. Using gloved fingers, about 10 grams of feces were obtained from each goat by digital rectal extraction and then immediately placed in a plastic bag. The bag was tightened as close to the feces as possible to keep off air. Each sample was carefully labeled with the details of the individual goat for identification, and put in a cold box containing ice packs. The samples were transported to the Veterinary Parasitology Laboratory, Makerere University within 12 h for analysis.

3.2. Detection of nematode eggs and estimation of fecal egg counts (FEC)

The simple test tube flotation method (Hansen and Perry, 1994) was used in the detection of the nematode eggs. Identification of nematode eggs was done as described by Soulsby (1982).

FEC were determined as number of eggs per gram (epg) for each sample using a Modified McMaster technique (MAFF, 1971). The detection level of the McMaster method used was 100 epg.

3.3. Fecal egg count reduction test

The epg of strongyle-type nematodes were subjected to the fecal egg count reduction test (FECRT) (Dash et al., 1988), to estimate anthelmintic efficacy. Arithmetic means of pre-and post treatment fecal egg counts were used to calculate the percentage efficacy of each anthelmintic using the following formula: $\text{FECR} = \{1 - [(T_2/T_1) \times (C_1/C_2)]\} \times 100$, where T_1 and T_2 are pre- and post treatment arithmetic means of the epg in treated groups, and C_1 and C_2 are pre- and post-treatment arithmetic means of the epg in the control group.

Efficacy of each anthelmintic was tested and interpreted according to the World Association for the Advancement of Veterinary Parasitology (WAAVP) recommendations for efficacy evaluations of anthelmintics (Coles et al., 1992). Reduction in efficacy and presence of anthelmintic resistance is considered to exist if the FECRT percentage of an anthelmintic treatment is <95% (Coles et al., 1992).

Table 2
Comparative FECR test using arithmetic means and confidence intervals in Mubende goats.

Groups	Arithmetic mean (mean ± SEM)		95% confidence interval		
	Day 0	Day 13	FECR %	LCL	UCL
ABZ (n = 11)	373 ± 68.9	454.6 ± 128.9	28.53	−58	35
LVM (n = 9)	389 ± 211.8	60 ± 40.0	91	62.5	100
IVM (n = 11)	755 ± 332.9	25 ± 16.4	98	88.15	100
Control (n = 9)	389 ± 185.2	663.6 ± 292.7	–	–	–

FECR, fecal egg count reduction; SEM, standard error of mean; LCL, lower confidence limit; UCL, upper confidence limit.; No significant difference in efficacy of the three drugs at 95% CI ($p < 0.05$) by ANOVA test.

3.4. Third stage larvae identification

For specific identification of nematode genera, about three grams of rectal fecal samples from each goat were pooled for each group. The pooled samples were incubated at 27 °C for seven days before and after treatment. The third stage larvae (L3) were recovered using Baermann technique (Hansen and Perry, 1994). The L3 were identified and counted under a compound microscope, according to morphological keys as described by MAFF (1971).

3.5. Statistical analysis

Statistical analysis was performed using Predictive Analytics SoftWare (PASW® Statistics 18). BootSteat method was used to provide 95% confidence intervals for anthelmintic efficacies, based on re-sampling-boot-straps (Cabaret and Antoine, 2008). One-way Analysis of Variance (ANOVA) and independent samples T test were used to compare anthelmintic efficacies within and between goat breeds.

4. Results

4.1. Arithmetic mean fecal egg count reductions

Tables 2 and 3 show results of efficacies of anthelmintics in Mubende and Boer crossbred goats, respectively. In Mubende goats, ivermectin (IVM) was found to be most effective with FECR of 98%, while albendazole (ABZ) was least effective with FECR of 28.53%. In Boer crosses, levamisole (LVM) was most effective with FECR of 84.88%, while albendazole was least effective with FECR of 11%. At 95% CI, only IVM was more effective in Mubende goats than Boer crosses ($t = 2.564$, $p < 0.05$).

4.2. Third stage larvae identified in coprocultures of experimental Mubende and Boer crossed goats

Third stage larvae identified in pretreatment fecal cultures of Mubende goats were *Haemonchus spp*, *Trichostrongylus spp*, *Oesophagostomum spp*, *Cooperia spp*, *Teladorsagia spp*, *Bunostomum spp* and *Nematodirus spp*. Nematode species identified in pretreatment fecal cultures of Boer crosses were *Haemonchus*, *Cooperia spp*, *Oesophagostomum* and *Teladorsagia spp*.

In post-treatment coprocultures, only *Haemonchus spp* and *Cooperia spp* were identified in Mubende goats, while *Haemonchus spp*, *Cooperia spp* and *Oesophagostomum spp* were found in Boer crosses.

5. Discussion

At dosages given, fecal egg count reduction in albendazole and levamisole, for both Boer crosses and Mubende goats, and ivermectin in Boer crosses were below 95%. This may suggest the existence of anthelmintic resistance (Coles et al., 1992). These findings agree with those of Bakunzi (2003) in South Africa and Keyyu *et al.* (2002) in Tanzania who reported reduced efficacy and development of resistance to benzimidazole and imidazothiazole drugs in *Haemonchus contortus* nematodes of goats.

In the present study, reduction in efficacy of anthelmintics may be explained by management practices on the farm, which could have reduced the level of refugia. These include: prolonged and frequent use of the same anthelmintic (albendazole), administration of anthelmintics to all goats, irrespective of their infection levels and grazing goats on the same traditional pastures for a long time. Low efficacy in levamisole in both Boer crosses and Mubende goats is reported, despite the fact that the drug was not used on the farm. This might be due to under dosing, since doses for sheep were used in the current study. Similar animal management practices

Table 3
Comparative FECR test using arithmetic means and confidence intervals in Boer crosses.

Groups	Arithmetic mean (mean ± SEM)			95% confidence interval	
	Day 0	Day 13	FECR %	LCL	UCL
ABZ (n = 8)	1050 ± 344.3	1766.7 ± 1156.6	11	−805	58.89
LVM (n = 8)	300 ± 94.5	85.7 ± 55.3	84.88	−103	100
IVM (n = 8)	737.5 ± 245.6	300 ± 96.4	78.47	20	82.73
Control (n = 7)	1728.6 ± 614.4	3266.7 ± 751.3	–		

FECR, fecal egg count reduction; SEM, standard error of mean; LCL, lower confidence limit; UCL, upper confidence limit. No significant difference in efficacy of the three drugs at 95% CI ($p > 0.05$) by ANOVA test.

resulted in the occurrence of multiple resistances in a goat flock in eastern Ethiopia (Sissay, 2007). Low efficacy of ivermectin could be due to the occasional use of the drug to treat clinical cases of helminthoses. This leads to a proportion of selected parasites, thus providing a pool of drug-resistant genes.

At dosages given, a 95% CI showed that only ivermectin was more effective in Mubende goats than Boer crosses. This may suggest that effectiveness of the same drug could differ when used in different goat breeds. This could have implications in control of worms in different goat breeds, when using anthelmintics. It might require that some classes of anthelmintics be used for shorter periods in some goat breeds than others, before rotation.

It is hoped that this study will be useful for stakeholders in the livestock sector, to promote practices that prevent anthelmintic resistance and preserve anthelmintic effectiveness. It is recommended that in Uganda and Africa, there is need to use the most suitable drugs, correct dosage and treat animals selectively rather than the entire flocks. It is also advised to avoid high frequency of treatments and apply appropriate grazing management. More studies are, however, needed to assess the status of efficacy of anthelmintics under different management systems and species of livestock in Uganda.

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