



A survey on anthelmintic resistance in nematode parasites of sheep in Lusaka, Zambia

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ABSTRACT

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While surveys in Southern Africa indicate anthelmintic resistance of gastrointestinal nematodes to be common in small ruminants in South Africa, Kenya and Zimbabwe there have been no reports of resistance in Zambia. The objective of this study was to determine whether anthelmintic resistance occurs in Zambia, and to obtain information on nematode control practices in the country.

During the rainy season six commercial sheep farms were selected in and around Lusaka and Chisamba. Worm control practices were gauged by means of a questionnaire, and the Faecal Egg Count Reduction Test was performed for assessing anthelmintic efficacy of albendazole, levamisole and ivermectin.

On all farms anthelmintic treatment was the only approach used to control nematode infections. Frequency of treatment varied from twice a year to every 6 weeks and drugs of different anthelmintic groups were alternated within the same year. There was a wide range in faecal egg counts of individual sheep before treatment, with some individual counts of up to 87 000. Larval identification showed that *Haemonchus* was almost the only genus recovered from the faecal cultures before and after treatment. Albendazole resistance was found on five of the six farms. On each of the four farms where ivermectin gave less than 95% reduction in egg counts, there was resistance to albendazole as well. Levamisole showed an efficacy of 95% or higher on all six farms.

Keywords: Anthelmintic resistance, benzimidazole, *Haemonchus contortus*, ivermectin, sheep, Zambia

INTRODUCTION

There has been an increasing number of reports from all parts of the world on anthelmintic resistance (AR)

of trichostrongyle nematodes in small ruminants (Jackson & Coop 2000). The situation is particularly serious in the main sheep breeding countries where multiple resistance has become very common. Among the most affected countries is South Africa where a recent survey demonstrated that on 93% of the farms *Haemonchus contortus* is resistant to at least one anthelmintic family, with 8% of the strains less than 40% susceptible to anthelmintics of four different activity groups (Van Wyk, Stenson, Van der Merwe, Vorster & Viljoen 1999).

Surveys in Kenya and Zimbabwe also indicate resistance, although less pronounced. In Kenya, resistance to at least one of the anthelmintic groups was shown on 57% of 42 farms (Wanyangu, Bain, Rugutt, Nginyi & Mugambi 1995); multiple resistance to both

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benzimidazole and levamisole occurred on 16% of 25 farms (Maingi, Bjorn, Gichohi, Munyua & Gathuma 1998); and Waruiru, Nogothon & Mukiru (1998) showed resistance to ivermectin on one farm. Reports from Zimbabwe demonstrate resistance to benzimidazole on six of ten farms surveyed, and to levamisole on two of three farms (Mukaratirwa, Charakupa & Hove 1997).

There are no previous reports on anthelmintic resistance in sheep in Zambia. Sheep farming constitutes a small percentage of livestock production in Zambia, but is increasing in importance. The objective of this study was to determine whether anthelmintic resistance occurs in Zambia, using the Faecal Egg Count Reduction Test (FECRT), and to obtain information on nematode control practices in Zambia.

MATERIALS AND METHODS

Farms and animals

Six commercial sheep farms in and around Lusaka and Chisamba were selected, based on the willingness of the farmers to participate in the project and on the size of the flocks (at least a total of 80 animals, Table 1). The number of sheep on the farms varied between 85 and 520, mostly of the Dorper breed. On three of the six farms the sheep had been imported from Zimbabwe. On none of the farms had sheep been imported directly from South Africa. Exchange of sheep between neighbouring farmers occurred frequently. All the sheep were kept free range, guided by a shepherd, but were gathered in pens at noon and overnight. Pastures were shared with cattle on most of the farms, although not simultaneously.

On each farm, a questionnaire was used to obtain information on nematode control and sheep management in general. On each farm a total of 60 sheep was selected that were certified not to have been dewormed for at least the previous 6 weeks. Most sheep were between 4 months and 3 years of age.

Experimental design

Before the survey started regular visits to the selected farms were performed and faecal nematode egg counts (FEC) measured until the required mean of 500 eggs per gram of faeces was reached in January, which falls with the rainy season.

The survey was performed between January and March 2001. During the first visit to each farm, 60 sheep were weighed, faecal samples obtained from the rectum, and randomly allocated to one of four groups each comprising 15 animals: one of which was nominated the non-medicated group. The sheep in the other three groups were treated orally with albendazole at 4 mg kg⁻¹, levamisole at 7.5 mg kg⁻¹ or ivermectin at 200–299 µg kg⁻¹ live mass (Anthel-

mintics used: Albendazole 10% drench, Dopharma, The Netherlands; Levicon drench, Milborrow, South Africa; and Ivomec tablets, Merial, ivermectin 10 mg). The sheep were allocated to each group in random sequence: the first four animals encountered in a crush each received one of the four treatments, and thereafter the same sequence of treatments was retained until the required number of 15 animals per group was attained.

The anthelmintics were administered with either hypodermic syringes (albendazole and levamisole) or a bolus applicator (ivermectin). A second farm visit was performed 10–14 days after the day of treatment during which faecal samples were collected from the same animals, while all animals of the control group were drenched with levamisole (7.5 mg kg⁻¹).

Parasitological techniques

Faecal worm egg counts (FEC) were determined by a modified McMaster method (Thienpont, Rochette & Van Parijs 1979) with a sensitivity of 50 eggs per gram (epg).

Bulk faecal cultures were prepared for each group on days 0 and 14. After incubation for 10 days at 27 °C, third stage larvae were recovered by Baermannisation and at least 100 larvae were identified per group (Anon. 1986).

Efficacy assessment

The anthelmintic efficacy was calculated according to the method described by Presidente (1985) using the geometric means of FEC of those sheep having counts of 150 epg or higher before treatment.

Resistance to the drug used was suspected when the efficacy was lower than 95% (Presidente 1985).

RESULTS

The results of the questionnaire are presented in Table 1.

On all farms anthelmintic treatment was the only method used to manage nematode infections. Frequency of treatment varied from twice a year to every six weeks and usually the whole flock was drenched on each occasion. There was a tendency to dose mostly before and after the rainy season. While all of the farmers had previously used benzimidazoles, three of the six stopped using this drug because of apparent lack of efficacy and had changed to ivermectin. Most farmers had been rotating drugs from different anthelmintic groups (albendazole, levamisole, ivermectin and closantel) from treatment to treatment. When the survey was undertaken on three of the six farms ivermectin was the only anthelmintic used. On only two of the farms were the sheep weighed before dosing.

TABLE 1 Results from the questionnaire

Farm	1	2	3	4	5	6
Management						
Number of sheep Import	150 Zimbabwe	150 Zimbabwe	180 No	520 No	120 Zimbabwe	85 Mazabuka
Treatment						
Frequency	4 per year	2 per year	4 per year	6–8 weeks	6–8 weeks	6 weeks in rainy season
Anthelmintics in use	BZ/IVM	IVM	CLOS/BZ	IVM	BZ/LEV/IVM CLOS	IVM
Rotation (per treatment)	Yes	No	Yes	No	Yes	No
Weighing before dosing	Yes, groups	No	No	No	Yes, groups	No
Other methods of control	No	No	Cleaning corral	No	No	No

BZ – benzimidazole; IVM – ivermectin; CLOS – closantel; LEV – levamisole

TABLE 2 Percentage reduction and geometric mean faecal egg counts on each farm

Farm	1	2	3	4	5	6
% reduction						
Albendazole	48.0	86.0	97.0	63.0	79.0	81.0
Levamisole	98.0	99.4	99.9	98.0	95.0	98.6
Ivermectin	72.0	94.0	99.8	78.0	99.0	90.0
Geomean epg	785.0	2 466.0	3 251.0	2 444.0	3 664.0	1 858.0
Highest epg	15 000.0	87 200.0	37 450.0	52 600.0	81 350.0	28 550.0

There was a wide range in individual FEC before treatment, with counts up to 87 200 EPG on one farm. Anthelmintic resistance was found on five of the six farms (Table 2). Albendazole had an efficacy lower than 95% on all but one farm, and lower than 60% on one of them. On four farms ivermectin reduced the FEC by less than 95%, and the worm strains on all of these farms also had resistance to albendazole. Levamisole showed an efficacy of 95% or higher on all six farms. Besides the identification of a few third stage larvae of *Cooperia* spp., only those of *Haemonchus* spp. were recovered from the faecal cultures, both before and after treatment.

DISCUSSION

The results of this limited survey suggest that resistance of *H. contortus* to two of the three currently used anthelmintic groups, i.e. benzimidazoles and macrocyclic lactones, is very common on sheep farms around Lusaka. The relatively high frequency of anthelmintic treatments of the whole flock, from twice a year to every 6–8 weeks, is likely to be the main cause for the development of resistance on five of the six farms in this study. The fact that on all farms benzimidazoles were the least effective, was prob-

ably the result of extensive use of it in the past. Other reasons for this high prevalence of resistance may be the importation of sheep from Zimbabwe where benzimidazole resistance is common (Boersema & Pandey 1997; Mukaratirwa *et al.* 1997), as well as is underdosing. In Zambia ivermectin is available for sheep only in tablet form, which may have led more often to incorrect dosages being administered. In addition, the choice and alternation of anthelmintics by the farmers seemed to have been done in a very arbitrary manner.

The fact that reduced efficacy against anthelmintics belonging to two of the three available broad spectrum anthelmintic families was found on most of the farms is of particular concern. This means that the only available alternative drug is levamisole, which was highly effective on the six farms tested. Helminth resistance to levamisole was found in Kenya (Maingi *et al.* 1998), Zimbabwe (Boersema & Pandey 1997), and on one of the farms in the present survey it was only 95% effective. However, this drug was also less affected by resistance in South Africa, probably because for many years it was used less frequently than other anthelmintics by sheep farmers (Van Wyk, Malan & Randles 1997). Since *H. contortus* is the main species occurring in sheep in the rainy season

in Zambia, the use of narrow-spectrum anthelmintics, such as closantel or rafoxanide, that are effective against haematophagous nematodes, should be considered for future use.

Without exception, the farmers in this study relied too much on anthelmintics for nematode control, evidently because they are easy to administer, there is a direct improvement in the health of the sheep after treatment and most of the drugs are relatively cheap. On the other hand, alternative methods, such as pasture management, are laborious and require some knowledge of the life cycle and epidemiology of the parasites, which is apparently lacking by most farmers. Among the novel approaches that have been suggested to reduce the frequency of anthelmintic treatments in livestock in the tropics (Waller 1997), is that of the introduction of breeds that are relatively resistant to worm infections. In addition, the FAMACHA[®] system could be considered for use under Zambian conditions.

This system comprises the clinical evaluation of anaemia by comparing the colour of the ocular mucous membranes of small ruminants to colours on a chart. As demonstrated in the summer rainfall regions of South Africa by Bath & Van Wyk (2001) drenching can be substantially reduced by identifying and drenching only those animals that are unable to withstand the worm challenge. However, in-depth studies of the local epidemiology of gastrointestinal strongyles and of anaemia-causing pathogens should be conducted before the introduction of the FAMACHA[®] system can be considered. The prior training of farmers and distribution of the system will require organization and planning.

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REFERENCES

- ANONYMOUS. 1986. Ministry of Agriculture, Fisheries and Food. *Manual of Veterinary Parasitological Laboratory Techniques*. London: HMSO.
- BOERSEMA, J.H. & PANDEY, V.S. 1997. Anthelmintic resistance of trichostrongylids in sheep in the highveld of Zimbabwe. *Veterinary Parasitology*, 68(4):383–388.
- BATH, G.F. & VAN WYK, J.A. 2001. Using the Famacha[®] system on commercial sheep farms in South Africa. *Proceedings of the 5th International Sheep Veterinary Congress, 22–25 January 2001, Stellenbosch, South Africa*.
- JACKSON, F. & COOP, R.L. 2000. The development of anthelmintic resistance in sheep nematodes. *Parasitology*, 120 Suppl.: S95–S107.
- MAINGI, N., BJORN, H., GICHOHI, V.M., MUNYUA, W.K. & GATHUMA, J.M. 1998. Resistance to benzimidazoles and levamisoles in nematode parasites of sheep in Nyandarua district of Kenya. *Acta Tropica*, 69:31–40.
- MUKARATIRWA, S., CHARAKUPA, R. & HOVE, T. 1997. A survey of anthelmintic resistance on ten sheep farms in Mashonaland East Province, Zimbabwe. *Journal of the South African Veterinary Association*, 68(4):140–143.
- PRESIDENTE, P.J.A. 1985. Methods for detection of resistance to anthelmintics, in *Resistance in nematodes to anthelmintic drugs* edited by N. Anderson & P.J. Waller. Australia, CSIRO: 13–28.
- THIENPONT, D., ROCHETTE, F. & VANPARIJS, O.F.J. 1979. *Diagnosis of verminosis by coprological examinations*. Beerse, Belgium: Janssen Research Foundation.
- VAN WYK, J.A., MALAN, F.S. & RANDLES, J.L. 1997. How long before resistance makes it impossible to control some field strains of *Haemonchus contortus* in South Africa with any of the anthelmintics? *Veterinary Parasitology*, 70:111–122.
- VAN WYK, J.A., STENSON, M.O., VAN DER MERWE, J.S., VORSTER, R.J. & VILJOEN, P.G. 1999. Anthelmintic resistance in South Africa: surveys indicate an extremely serious situation in sheep and goat farming. *Onderstepoort Journal of Veterinary Research*, 66:273–284.
- WALLER, P.J. 1997. Nematode parasite control of livestock in the tropics/subtropics: the need for novel approaches. *International Journal for Parasitology*, 27:1193–1201.
- WANYANGU, S.W., BAIN, R.K., RUGUTT, M.K., NGINYI, J.M. & MUGAMBI, J.M. 1996. Anthelmintic resistance amongst sheep and goats in Kenya. *Preventive Veterinary medicine*, 25:285–290.
- WARUIRU, R.M., NOGOTHO, J.W. & MUKIRU, J.G. 1998. Multiple and multigenic resistance on a sheep farm in Kenya. *Tropical Animal Health and Production*, 30:159–166.