The prevalence of anthelmintic resistance in nematode parasites of sheep in Southern Latin America: Paraguay

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Abstract

This survey to detect anthelmintic resistance in nematode parasites of sheep was conducted on 11 farms in the Occidental and 26 farms in the Oriental Regions of Paraguay using the faecal egg count reduction test (FECRT). The anthelmintic groups tested were the benzimidazoles, levamisole and avermectins (both oral and injectable). Overall the levels of resistance were 73%, 68%, 73% and 47%, respectively. Levels of resistance were similar for all three important nematode genera, viz. Haemonchus contortus, Ostertagia and Trichostrongylus. This survey clearly indicates that a large, and ever increasing, proportion of sheep farmers are rapidly approaching the time when they will have exhausted all chemotherapeutic options to control parasites. Unless they face having to abandon their sheep farming operations, radical changes will need to be implemented with urgency.

Keywords: Sheep-Nematoda; Ostertagia spp.; Trichostrongylus spp.; Haemonchus spp.; Resistance; Paraguay

1. Introduction

Paraguay is bordered to the south and south-east by Argentina, west and north-west by Bolivia and north and north-east by Brazil. The country is divided into two broad
regions by the Paraguay River, namely the Occidental and Oriental Regions, on the basis of rainfall (Fig. 1). The Occidental Region in the north-west of the country is classed as hot and relatively dry, becoming more arid towards the Bolivian border. The Oriental Region in the east is warm to hot and humid. Median annual temperatures never fall below 20°C in any area and annual rainfall ranges from over 1700 mm year\(^{-1}\) in the eastern Oriental Region to 400 mm year\(^{-1}\) in the western Occidental Region.

The sheep population of Paraguay, compared with that of neighbouring countries, is small. The total population of approximately 370 000 is concentrated in the Oriental Region (70%) where the bulk of the 9 million cattle in Paraguay are also found. There are, however, a relatively large number of sheep found in the Presidente Hayes district of the eastern Occidental Region. Typically, sheep are maintained in small flocks, rarely more than 200 animals, but often on large estancias which carry substantial numbers of cattle. Sheep flocks are commonly confined to small areas where they are maintained at very high stocking rates. In certain districts some sheep–cattle mixed grazing is practised. The sheep industry is based on European sheep breeds, Hampshire, Corriedale and Romney Marsh, not renowned for high levels of innate resistance to parasites, in regions of high temperature and humidity and at high stocking rates. Many specifically
designated sheep pastures are regularly inundated following heavy rains or flooding. Although the total number of sheep in Paraguay may be considered insignificant, they are to the individual farmer a very important component in his economy. Major problems with helminths are regularly encountered in sheep flocks throughout the year, especially in the Oriental Region. The seriousness of the problem is illustrated by recent reports from the region that many farmers have to treat sheep every 3–4 weeks with anthelmintics in order to prevent mortalities. This perennial, per acute helminthosis is largely attributed to *H. contortus*, however, *T. colubriformis* is also a major problem. Many other parasite species are also well represented.

2. Materials and methods

Selection of farms used in this survey was made through consultation with the Sheep Farmers Association (Asociación Paraguaya de Criadores de Ovino). The basic criteria for selection was a minimum flock size of 50 sheep and a willingness of the owner to participate in the survey. Owners were instructed that sheep should not be treated with anthelmintic for at least 30 days before the test (40 days for ivermectin). It was considered not reasonable to expect farmers to withhold sheep from treatment for a longer period because of the real threat of losses occurring due to parasites. The survey was conducted between April and July 1994, initially involving 48 farms. The field work was carried out by the staff of Laboratorio de Diagnostico e Investigacion Veterinaria (LIDIAV) who received a training course prior to the survey to ensure standardised procedures. In addition, staff of Departamento de Investigacion y Produccion Animal (DIPA) assisted in the selection of farms which were included in the project. Pre-treatment faecal samples were collected to exclude those farms with flocks with a mean faecal egg count of less than 200 epg. This resulted in selection of 26 and 11 farms in the Oriental and the Occidental Regions, respectively, for the faecal egg count reduction test (FECRT). Because of the small flock size on many of the farms, sheep up to 4 years of age were used. These were evenly distributed across all groups, although comparisons between egg counts of old and young sheep showed no consistent differences between age classes. Ten animals were randomly allocated to the following groups, marked with an identifying brand and treated according to individual liveweight:

- **Control** – No treatment.
- **FBZ** – Fenbendazole 7.5 mg kg⁻¹ (‘Panacur’, Hoechst).
- **LEV** – Levamisole 7.5 mg kg⁻¹ (‘Coopersol’, ICI).
- **IVM (I)** – Ivermectin 0.2 mg kg⁻¹ s.c. injection (‘Ivomec’ injectable and Merck, Sharp & Dohme).
- **IVM (O)** – Ivermectin 0.2 mg kg⁻¹ oral (‘Ivomec’, Merck, Sharp & Dohme).

Tests on the efficacy of FBZ and LEV were conducted on all 37 farms whereas for IVM, 24 and 11 tests for the injectable and oral formulations, respectively, were carried out on the 26 farms in the Oriental Region. In the Occidental Region, eight tests with IVM injectable and four tests with IVM oral were performed on the 11 farms. Testing for IVM resistance was in accordance with the method each farmer used for IVM administration and on some farms both applications had been used and were tested
accordingly. At the same time as these procedures were carried out, farmers were asked to complete a questionnaire seeking information about the size, structure and management of their flock.

Ten to 14 days following treatment all animals were faecal sampled again and these samples were consigned to the LIDIAV (Laboratorio de Diagnostico e Investigacion Veterinaria) Laboratory, San Lorenzo, for all laboratory procedures. Faecal egg counts, larval differentiation and analysis of data was in accordance with the guidelines specified in Anonymous (1989).

3. Results

Questionnaire results showed that 40% of sheep farmers in the Oriental Region treated their sheep on 12 or more occasions each year, with approximately 30% treating fewer than 4 times year \(^{-1}\). Farmers were also asked whether they considered anthelmintic treatment improved the condition of their flock; the majority (80%) thought that this was the case. The questionnaire of the 11 farmers in the Occidental Region showed that only one treated sheep with anthelmintic every month, with all the rest treating 4 times year \(^{-1}\) or less. All farmers in this region considered that anthelmintic treatment improved the condition of their sheep. All farmers used more than one anthelmintic group in the previous 12 months, with the most favoured being levamisole (77% Oriental, 55% Occidental); ivermectin was also popular (65% Oriental, 43% Occidental) with somewhat less use of the benzimidazoles (42% Oriental, 9% Occidental). The choice of anthelmintic was based on availability, price, fashion, advertising and perceived effectiveness.

The prevalence of resistance to the benzimidazoles, levamisole and ivermectin in nematode parasites of sheep flocks in the Oriental and Occidental regions of Paraguay are shown in Table 1.

Overall, the levels of resistance exceeded 50% to all anthelmintics and formulations (oral and injectable ivermectin) in both regions with no indication of any difference between regions.

Table 1
Percentage of farms with anthelmintic resistance in sheep nematodes in Paraguay

<table>
<thead>
<tr>
<th>Region</th>
<th>Anthelmintic</th>
<th>Benznimidazole (BZ)</th>
<th>Levamisole (LEV)</th>
<th>Ivermectin (IVM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Injectable</td>
<td>Oral</td>
<td>Injectable</td>
</tr>
<tr>
<td>Oriental</td>
<td></td>
<td>(26)</td>
<td>(26)</td>
<td>(24)</td>
</tr>
<tr>
<td>26 farms</td>
<td>81%</td>
<td>69%</td>
<td>42%</td>
<td>82%</td>
</tr>
<tr>
<td>Occidental</td>
<td>73%</td>
<td>(11)</td>
<td>(11)</td>
<td>(8)</td>
</tr>
<tr>
<td>11 farms</td>
<td>55%</td>
<td>64%</td>
<td>63%</td>
<td>50%</td>
</tr>
</tbody>
</table>

* Number of farms in brackets on which test conducted.
Table 2
Anthelmintic resistance status of nematode parasites of sheep in Paraguay

<table>
<thead>
<tr>
<th>Anthelmintic</th>
<th>Parasite genus (percentage resistance)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H. contortus</td>
</tr>
<tr>
<td>Benzimidazoles</td>
<td>70</td>
</tr>
<tr>
<td>Levamisole</td>
<td>47</td>
</tr>
<tr>
<td>Ivermectin – inj.</td>
<td>35</td>
</tr>
<tr>
<td>Ivermectin – oral</td>
<td>67</td>
</tr>
</tbody>
</table>

Comparison between the levels of resistance between anthelmintic groups for the three main parasite genera, H. contortus, Ostertagia and Trichostrongylus spp. are shown in Table 2.

There is clear evidence that all species have a high level of resistance to all three broad-spectrum anthelmintic groups. Examination of the FECRT data for individual farms showed that on many the level of resistance was very high, illustrated by very low reductions (< 50%) in faecal egg counts post-treatment. The most extreme situations showed post-treatment egg counts exceeding those made at the time of anthelmintic treatment. This was observed for all anthelmintic groups, including ivermectin.

4. Discussion

Surveys of the prevalence of anthelmintic resistance of sheep parasites are becoming increasingly more numerous (for reviews see Boray et al., 1990; Waller, 1994), following the general recognition of the increasing seriousness of the problem, but the situation in Paraguay, as indicated by this recent survey, is by far the worst recorded in the world. Levels of resistance in the most important nematode genera, viz. H. contortus, Ostertagia and Trichostrongylus spp. to the benzimidazoles and the levamisole/morantel groups, in which resistance is invariably reported, are of the same order as in other sheep producing countries in the Southern Hemisphere where resistance tends to be greatest (Waller, 1994). What is alarming, however, is the very high level of resistance to ivermectin. There is an indication that the injectable formulation is slightly more efficacious, which is likely to be due to the longer residence time of the drug in the animal compared with the oral formulation (Fink and Porras, 1989). However, with the average level of ivermectin resistance at approximately 60%, the effectiveness of the macrocyclic lactone class of anthelmintics must be considered, at best, severely compromised.

There is no indication that the prevalence of resistance in the Occidental Region is less than in the Oriental Region where, based on farmer responses to questionnaires, the frequency of anthelmintic treatment is much less. The high level of resistance in the Occidental Region suggests that, in many instances, farmers have imported the problem onto their farms due to the common practice of sheep trading and transfer.

Clearly the level of anthelmintic resistance in nematode parasites of sheep and, by inference, goats, in Paraguay has reached a crisis situation. Although this 'chemo-
therapeutic endpoint’ was predictable, on the basis of precedent shown by the evolution of chemical resistance in a range of target pests (Waller, 1994), there is no clear path forward, either chemotherapeutically or non-chemotherapeutically, for sheep farmers to at least contain helminth parasitism in their flocks. Radical changes in sheep management, together with assessing alternative anthelmintic options with narrow spectrum drugs, on a farm-by-farm basis need to be made immediately. In the short term, detailed studies on the epidemiology and ecology of nematode parasites need to be made to develop scientifically based control strategies, together with studies on non-chemotherapeutic options such as genetic selection for resistant hosts and biological control.

Acknowledgements

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References