A telephone survey of internal parasite control practices on sheep farms in Spain

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Keywords
Nematode
Control
Anthelmintic
Survey
Sheep
Spain
ABSTRACT

A telephone survey of farmers was conducted to determine current internal parasite control practices on sheep farms in Spain; the farmers were interviewed by their veterinarians. Anthelmintic choice was largely on veterinary advice and dominated by benzimidazoles and macrocyclic lactones. Anthelmintic rotation was separated into: no rotation (42% of farms); annual rotation (36%); rotate within year (20%); and rotate every second year (2%). The mean annual number of treatments varied subtly by region; ewes and rams 1.6–2.1, replacement lambs 1.7–2.1. Anthelmintics are administered primarily during spring and early summer (47% of treatments), and autumn (41%). Thirty-two percent of farmers introduced sheep to their properties and more than half did not quarantine drench the arrivals.

1. Introduction

The prevalence of anthelmintic resistance in nematodes of small ruminants is largely unknown in the sheep farming regions of Spain. Despite earlier suspicions of resistance (Coles et al., 1993), the first confirmed case was that of benzimidazole resistance identified in Teladorsagia circumcincta infecting goats but associated with the importation of animals from Scotland (Requejo-Fernández et al., 1997). Subsequent to this finding, several regional surveys have been conducted to determine the prevalence of anthelmintic resistant nematode populations on sheep farms in the country. Faecal egg count reduction tests, egg hatch assays and/or larval feeding inhibition assays were used to measure drug resistance (i.e. reduced efficacy) in these surveys.

Álvarez-Sánchez and colleagues (2006) reported that all broad-spectrum anthelmintic classes available at the time were affected by resistance in the north-western region of Castilla y León: benzimidazole, eight farms identified with resistance from 63
tested (12.7%); levamisole, nine farms from 26 tested (34.6%); and macrocyclic lactones, eight farms from 51 tested (15.7%). Pre- and post-treatment faecal coprocultures indicated *Teladorsagia* and *Trichostrongylus* were the main genera present. No parasite populations showed resistance to the three families, although six were recorded as being resistant or suspected as being resistant to two families.

A second survey (Díez-Baños et al., 2008) examined the efficacy of benzimidazoles and macrocyclic lactones on 72 farms in the region of Galicia (also in the north-west). Using data from faecal egg count reduction tests, resistance to benzimidazoles was identified on 13 of 72 farms (18.1%) and to the macrocyclic lactones on two of 72 farms (2.8%). *Teladorsagia circumcincta* and *Trichostrongylus* spp. dominated coprocultures from benzimidazole-treated groups and only the former was recovered from coprocultures from macrocyclic lactone-treated animals.

In 2007–2009, a survey (n=107 farms) to determine the frequency of benzimidazole-resistance with a concurrent examination of contributing management and environmental factors was undertaken in the Aragon region of north-east Spain (Calvete et al., 2012). The estimated frequency of benzimidazole-resistance was 11% (determined by egg hatch assay), the sheep were treated 0.5–3 times/year, and spring and autumn were the predominant treatment periods.

Martínez-Valladares et al. (2012) recently characterised a *T. circumcincta* isolate from the province of León (in the region Castilla y León) finding resistance to levamisole and the macrocyclic lactones. The efficacy of the latter drug class varied with active ingredient and formulation type.

A survey (n=49 farmers) of parasite control practices was completed in Galicia in 2001–2002 (Pedreira et al., 2006). In summary, anthelmintic treatment (1–2 times/year) was identified as the only parasite control practice and there was minimal interaction between
the farmers and their veterinarians. Sheep were primarily treated in the spring or spring and
autumn. No farmers completed faecal worm egg counts from their sheep before or after
treatment and there was no quarantine anthelmintic treatment of incoming animals.

Aside from the regionalised surveys of Pedreira et al. (2006) and Calvete et al.
(2012) there appears to be no published evidence of farmer practices in internal parasite
treatment of incoming animals. The release in Europe of both monepantel, the first amino-acetonitrile derivative
anthelmintic to be developed for sheep (Kaminsky et al., 2008a,b) and a combination
product containing abamectin + derquantel, the latter being the first spiuroindole anthelmintic
to be developed for sheep (Little et al., 2010, 2011) brings a responsibility for animal health
professionals to understand how best to incorporate new anthelmintics into existing
nematode control programs in a way that is least selective for resistance genotypes.
Moreover, the opportunity of identifying how a new class could be used to help extend the
lives of the older anthelmintics could also be explored as has been the case in New Zealand
(Leathwick and Hosking, 2009) and Australia (Dobson et al., 2011a,b).

As a first step to providing guidance to veterinarians and animal health advisers in
Spain on the use of new anthelmintics, the currently used internal parasite control practices
and particularly the timing of treatments need to be better understood. In the absence of this
type of information for Spain, a telephone survey of sheep farmers was conducted and the
findings are reported herein.

2. Materials and methods

The survey was undertaken during the last quarter of 2008 and first half of 2009.
Veterinarians with an interest in sheep medicine conducted telephone interviews with
farmers selected from their practices (these were often associated with sheep breeding
associations or cooperatives). The survey protocol defined that farmers were to be selected at random but the potential for bias to occur in the selection process did exist, e.g. only those farmers likely to be amenable to interview may have been contacted. Each farmer participant was asked questions relating to farm and stock management, sheep demographics, and nematode control practices including treatment times, products, sources of advice and knowledge of anthelmintic resistance. The number of farmers to be interviewed in a defined region was determined on the basis of distribution of sheep in that region (i.e. the more sheep farmed, the greater the number of planned interviews). Survey responses were collated into spreadsheets (Microsoft Excel) and analysed. No statistical comparisons or repeatability evaluations (Scholl et al., 1994) were undertaken for this survey.

3. Results

Completed questionnaires (n=201 from a planned 450) were received from the veterinarians who interviewed the farmers. This low completion rate was attributed to the veterinarians needing to focus their attentions on Bluetongue Virus at the same time the survey was being conducted as opposed to farmers not being prepared to participate in the survey. Of the 201 responses, 196 were considered valid and therefore used in the analysis.

Approximately 65% of the sheep in Spain are farmed in the regions surveyed, viz. Andalucia (12%), Castilla y León (21%), Castilla-La Mancha (14%) and Extremadura (18%) (Ministry of Environment and Rural and Marine Affairs, Government of Spain). These regions are within the major areas for sheep meat and milk production (as evidenced by the sheep breeds described in Table 1). Galicia (Pedreira et al., 2006) and Aragon (Calvete et al., 2012) were not included in the present survey. After an initial breakdown of
farm location to the provincial level, it was determined that the data would be analysed at regional and ‘whole’ country levels (Table 2).

3.1 General information

Farmers were asked for some general information about their farms and farming practices, particularly in relation to type of farming and their sheep being housed indoors. Durations of housing varied and in some responses, time periods were not recorded and were replaced by a description of associated events (e.g. lambing, milking etc.). In such instances, an estimate was made of housing duration based on the information provided by other respondents in the specific province (Table 1). In cases where a range of parameters was given, the mean value was calculated and used in the analysis. The country-wide analysis indicated that 88% of the farmers housed their sheep for at least part of the year and the average duration of housing was four months.

Predominant sheep breeds (cross-breeds have been included as the base breed) and mean (range) flock size, and structure are provided in Table 1; ‘replacements’ were considered to be all females, although some farmers did retain a small number of males for breeding purposes. There was inadequate information presented for many farms with respect to farm size and percentage of land area grazed by sheep and so this information has been excluded. There was a clear trend for different breeds to be farmed in different regions.

Only 7% of the interviewees confirmed that they also farmed cattle. The numbers of cattle, age structure of the herd and purpose were varied, with no defined pattern determined in the analysis. A small percentage of these farmers grazed sheep and cattle over the same pastures.

3.2 Product usage
Three (1.5%) respondents confirmed they never used anthelmintics; one of these used a homeopathic remedy although the composition of this was not specified. Approximately 12% of the responses indicated that anthelmintics were used in certain animal classes but the type of anthelmintic used was not stated. Despite this missing information, there was no clear trend on the anthelmintics used within the four regions. Anthelmintic choice varied between farms and was dominated by the benzimidazoles and macrocyclic lactones. A number of farmers elected to use combinations of closantel + benzimidazole, triclabendazole + levamisole and oxyclozanide + levamisole, presumably for strategic control of *Oestrus ovis* (main purpose for closantel treatments) and trematodes (primarily *Fasciola hepatica*). Nitroxynil was used on a small number of farms and benzimidazoles may have been specifically used for the treatment of *Dicrocoelium dendriticum* on some occasions. Anthelmintic selection was largely on veterinary advice (92%) with significant gaps to price (24%) and convenience (17%).

A question on the rotation of anthelmintics was poorly answered. After the data set was cleaned there were 157 valid responses, which could be separated into four clusters – no rotation (42% of farms); annual rotation (36%); rotate within a year (20%); and rotate every second year (2%). For those that rotated annually, 25% had continued to use the same drug class, i.e. different active ingredients from the same class (benzimidazole). The comparable percentage was much less for those farmers rotating within a year.

Treatments for the control of *O. ovis* and *F. hepatica* were administered by 12% of the farmers. There were subtle differences in frequency between Andalucia (10%), Castilla y León (9%) and Castilla-La Mancha (7%) but one-third of farmers in Extremadura treated for at least one of these parasites. There were 193 valid responses to two questions on *Moniezia expansa*. Only 3% of the respondents thought this parasite presented a problem but 17% (regional range 4–33%) still treated their sheep for it. The drug of choice was generally a
benzimidazole, but macrocyclic lactones and closantel, which are not effective against this cestode, were other anthelmintics cited as being used. It is possible that these treatments were not specifically targeted at *M. expansa*.

### 3.3 Number of treatments and application times

The mean number (and range) of treatments administered to the three sheep classes are summarised in Table 3. There were some instances when sheep may have received an additional treatment for a particular reason, which was not defined in survey responses and such deviations were not accounted for in this analysis. An analysis of month of treatment by region and animal class was undertaken (Figure 1). It was apparent from this analysis that various sheep classes on a farm are most often treated at comparable times. In some cases, treatment times were not defined by month but by season or farming event. Where possible such data was included in the analysis with the assumption that treatment time was similar to other classes on the specific farm where treatment times had been identified by month. If this was not possible the data was excluded from this part of the analysis. Several respondents stated that they treated ‘as required’ or ‘at random’ and such responses were discounted.

### 3.4 Anthelmintic resistance

The survey responses would suggest that Spanish sheep farms are not greatly affected by anthelmintic resistance (in the opinion of the farmers surveyed). There was however, an imbalance in some of the responses received. For example, 62% of the respondents considered they knew the anthelmintic resistance status of the nematode populations on their farm yet only 43% stated they had tested for resistance. Surprisingly, only 3% of the farmers stated they had a problem with resistant parasites (although this does
not necessarily mean resistance is not present on the farm, i.e. resistant parasites may be present but not considered a problem), 61% said they had no problem and the balance did not know. There was a trend for the latter answer to be given in some provinces and this suggests the answers may have been biased somewhat in either the way the question was asked or the answer recorded. One-third of the farmers interviewed were worried about anthelmintic resistance and the impact it could have on their farms.

3.5 Purchase and quarantine treatment of sheep

The responses to questions on treatment (management and drug) of sheep introduced to the farm were varied. The practices surrounding the introduction of these sheep are summarised in Table 4. In the country analysis, 32% of farmers introduced sheep to their properties. Nineteen percent of these farmers always placed the animals into a quarantine environment for an average 20.9 days (range 7–40) while 26% sometimes managed the incoming animals in this manner. Fifty percent of farmers never quarantine managed imported sheep. There was no response from 5% of the farmers. More than half of the farmers who introduced sheep to their farms did not quarantine drench the imported animals on arrival at the farm.

3.6 Sources of advice for parasite control

Veterinarians (92%) and other farmers (68%) were the primary sources of information for internal parasite control. The regional analysis was excluded because of this dominance in seeking veterinary advice. Of the farmers who planned their own internal parasite control, only 14% did not consult their veterinarian at some point.

4. Discussion
The objective of this survey was to identify provincial and regional internal parasite (principally nematodes) control practices on farms in the primary sheep farming areas of Spain. The provincial analysis is not reported because of the small sample size for some provinces; this small sample size (196 usable responses from a planned 450) has limited the interpretations to be drawn from the survey.

Anthelmintics were used on more than 98% of the surveyed properties and anthelmintic selection was largely on veterinary advice. This latter point would be expected given the dominance the veterinarian has in providing information to the farmers surveyed and noting the interviewers were veterinarians. This finding is in contrast to those of Pedreira et al. (2006) who reported only 11% of farmers in Galicia followed the advice of their veterinarian.

The mean number of treatments was low with regional trends for application times evident. Spring and autumn were clearly the dominant treatment periods, with most probably the autumn treatment including a flukicide for some properties. The majority of anthelmintics are administered to sheep during March–June (47% of treatments), and September–November (41% of treatments). Parasitologically it is not unexpected to see this pattern of treatment as weather conditions would favour parasite development at these times. Moreover it appears, although the question was not directly asked, that treatments are often being associated with key farming events, e.g. pre-mating in autumn, post-lambing in spring or shearing time in late spring/early summer. Sheep in Castilla-La Mancha and Andalucia tended to be only treated in the spring months as opposed to spring and early summer. This resulted in a greater frequency of treatments in the first month of autumn for these regions compared to Castilla y León and Extremadura (Figures 1a–c). This is likely due to the climate being hotter and drier during the summer months in the Castilla-La Mancha and Andalucia regions than in Castilla y León and Extremadura.
Approximately one-third of the farmers did not know the resistance status on their farms and anthelmintic resistance did not appear to be a major concern to them. Only 3% of those interviewed could confirm they had resistant nematode populations on their farms. This is in contrast to the results of three localised drug resistance surveys in Spain that found 11–18% of farms affected (Álvarez-Sánchez et al., 2006; Díez-Baños et al., 2008; Calvete et al., 2012). The numbers of farmers who said they had tested for anthelmintic resistance was high (43%) in comparison to other countries of Europe. A recent survey of internal parasite control practices on 600 farms in Great Britain and Ireland showed anthelmintic efficacy had been assessed on only 19% of farms (Morgan et al., 2012) while no interviewees in a limited survey of 74 French farmers had checked for resistance (P. Dorchies and B. C. Hosking, pers. obs.).

Limited numbers of farmers stated they quarantined drenched incoming stock and for those that did treat, their choice of anthelmintic was often poor, i.e. a benzimidazole. No farmers treated with moxidectin or a combination of several broad-spectrum classes to help minimise the risk of importing resistant nematodes. Similarly, with one exception, there was no evidence that quarantine treatments with a flukicide were administered. One farmer specified he used nitroxynil, which has activity against mature fluke only.

The type of information generated from this survey, albeit limited, provides veterinarians with a foundation on which they can build recommendations for the sustainable use of anthelmintics in Spain. Mathematical models have been used in several sheep farming countries to help identify what products and treatment regimes have the most impact on selecting for drug resistance in nematodes (Leathwick and Hosking 2009; Dobson et al., 2011a,b), and veterinarians can use this information when designing internal parasite control programs in these countries. Unfortunately similar models don’t currently exist for
Spain and therefore veterinarians need to make risk-based decisions on how best to utilise anthelmintics in their local environment.

Spanish sheep farmers now have access to at least one new broad-spectrum anthelmintic class and this reduces, but doesn’t remove, the threat that drench resistance poses in the longer-term. Effective rotation-based programs between the available drug classes (new and old) appears to be a good option in Spain, with the new anthelmintics easing the burden placed on the older classes (to which resistance has been confirmed on some farms). Drug classes affected by resistance on a particular farm should generally be excluded from such rotations unless in combination with a new class although the level of resistance to the old class is important for some parasites (Kaminsky et al., 2011; George et al., 2012; Sager et al., 2012). This survey indicates that rotation is already practiced by about 58% of the respondents although a small number of farmers are unknowingly alternating between drugs of the same anthelmintic class.

Leathwick et al. (2009) described important management practices to slow the development of drug resistance on New Zealand sheep farms and these serve as a good starting point for veterinarians in Spain. In New Zealand, the strategy for managing the development of anthelmintic resistance in all-year-round pastoral sheep farming was based on identifying and mitigating high-risk treatment and stock management practices, maintaining a refugium of drug-susceptible genotypes, and using combination anthelmintics (Leathwick et al., 2009). It is proposed that these broad categories will principally be the same irrespective of country and that categories 1 and 2 are applicable to any anthelmintic used in farmed livestock.

5. Conclusions
This survey has identified the key periods when sheep farmers in Spain treat their flocks with anthelmintics. In any control program, the veterinarian needs to consider if any treatments are more selective for drug resistance than others and if so, what mitigating measures can be applied to minimise the impact. It seems appropriate to consider the tactics recommended for New Zealand in treatment programs and moreso while the incidence of anthelmintic resistance in Spain is still at low–moderate levels. Continued education of sheep farmers in parasite control would be beneficial.

**Conflict of interest statement**

This survey was funded by Novartis Animal Health Inc., Basel, Switzerland. B. C. Hosking is a paid employee of Novartis Animal Health Australasia Pty Limited.

**Acknowledgements**

The authors wish to thank Antonio Ramiro and Pedro Nuñez Ulibarri for their critical reviews of a draft version of this paper.

**References**


Ministry of Environment and Rural and Marine Affairs, Government of Spain


Figure legend

Fig 1. Anthelmintic treatments administered each month (calculated as a percentage of the total treatments administered; y-axis) to ewes (Fig. 1a), rams (Fig. 1b) and replacement lambs (Fig. 1c).
Table 1

Farm type, housing of sheep and flock demographics.

<table>
<thead>
<tr>
<th>Region</th>
<th>Farm type (% of flocks)</th>
<th>Housed (% of flocks)</th>
<th>Duration (months)</th>
<th>Main breeds</th>
<th>Mean flock size (range)</th>
<th>Replacement lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed</td>
<td>Extensive shepherding</td>
<td>Other</td>
<td>Mean</td>
<td>Range</td>
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<td>Andalucia</td>
<td>60</td>
<td>40</td>
<td>0</td>
<td>95</td>
<td>2.4</td>
<td>1.0–6.0</td>
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<tr>
<td>Castilla y León</td>
<td>67</td>
<td>15</td>
<td>18</td>
<td>95</td>
<td>3.8</td>
<td>1.0–12</td>
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<tr>
<td>Castilla-La Mancha</td>
<td>94</td>
<td>2</td>
<td>4</td>
<td>94</td>
<td>5.3</td>
<td>1.7–12</td>
</tr>
<tr>
<td>Extremadura</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>67</td>
<td>2.1</td>
<td>1.7–4.5</td>
</tr>
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</table>
Table 2

Valid survey responses by region and province (within each region).

<table>
<thead>
<tr>
<th>Region</th>
<th>Province</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andalucia (n=20)</td>
<td>Córdoba</td>
<td>2</td>
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<td></td>
<td>Granada</td>
<td>12</td>
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<tr>
<td></td>
<td>Sevilla</td>
<td>6</td>
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<tr>
<td>Castilla y León (n=91)</td>
<td>Burgos</td>
<td>40</td>
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<td></td>
<td>León</td>
<td>10</td>
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<tr>
<td></td>
<td>Palencia</td>
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</tr>
<tr>
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<td>Salamanca</td>
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</tr>
<tr>
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<td>Segovia</td>
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</tr>
<tr>
<td></td>
<td>Valladolid</td>
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</tr>
<tr>
<td></td>
<td>Zamora</td>
<td>5</td>
</tr>
<tr>
<td>Castilla-La Mancha (n=55)</td>
<td>Albacete</td>
<td>15</td>
</tr>
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<td></td>
<td>Ciudad Real</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Cuenca</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Toledo</td>
<td>4</td>
</tr>
<tr>
<td>Extremadura (n=30)</td>
<td>Badajoz</td>
<td>23</td>
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<tr>
<td></td>
<td>Cáceres</td>
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</table>
### Table 3

Number (range) of anthelmintic treatments administered to sheep per year.

<table>
<thead>
<tr>
<th>Region</th>
<th>Ewes</th>
<th>Rams</th>
<th>Replacement lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (range)</td>
<td>Mean (range)</td>
<td>Mean (range)</td>
</tr>
<tr>
<td>Andalucia</td>
<td>1.9 (0–2)</td>
<td>1.8 (0–2)</td>
<td>1.9 (0–2)</td>
</tr>
<tr>
<td>Castilla y León</td>
<td>2.0 (0–4)</td>
<td>1.9 (0–4)</td>
<td>1.8 (0–4)</td>
</tr>
<tr>
<td>Castilla-La Mancha</td>
<td>1.6 (1–3)</td>
<td>1.6 (1–3)</td>
<td>1.7 (1–3)</td>
</tr>
<tr>
<td>Extremadura</td>
<td>2.1 (1–3)</td>
<td>2.1 (1–3)</td>
<td>2.1 (1–3)</td>
</tr>
</tbody>
</table>
### Table 4

Quarantine management practices applied to imported sheep.

<table>
<thead>
<tr>
<th>Region</th>
<th>Farms in region introducing stock (n=%)</th>
<th>Farms (%) applying a quarantine period</th>
<th>Duration of period (mean days)</th>
<th>Number of farms using quarantine treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farms (%)</td>
<td>Always</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>Andalucia</td>
<td>2 (10)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Castilla y León</td>
<td>42 (46)</td>
<td>17</td>
<td>24</td>
<td>59</td>
</tr>
<tr>
<td>Castilla-La Mancha</td>
<td>7 (12)</td>
<td>40</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Extremadura</td>
<td>8 (27)</td>
<td>0</td>
<td>38</td>
<td>62</td>
</tr>
</tbody>
</table>
Figure

Fig. 1a

Fig. 1b

Fig. 1c

Andalucía
Castilla y León
Castilla-La Mancha
Extremadura

% treatments administered

0 10 20 30 40 50 60 70 80

January February March April May June July August September October November December

% treatments administered

0 10 20 30 40 50 60 70 80 90