Veterinary Parasitology 212 (2015) 439–443

Contents lists available at ScienceDirect

Veterinary Parasitology

journal homepage: www.elsevier.com/locate/vetpar

Short communication

Frequency of cattle farms with ivermectin resistant gastrointestinal nematodes in Veracruz, Mexico

M.A. Alonso-Díaz[a,*], R.A. Arnaud-Ochoa[a], R. Becerra-Nava[a], J.F.J. Torres-Acosta[b], R.I. Rodriguez-Vivas[b], R.H. Quiroz-Romero[c]

[a] Centro de Enseñanza, Investigación y Extensión en Ganadería Tropical, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, Km. 5.5 Carretera Federal Tlapacoyan-Martínez de la Torre, C.P. 93600 Martínez de la Torre, Veracruz, Mexico
[b] Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Yucatán, Km 15.5 Carretera Mérida-Xmatkuil, Mérida, Yucatán, Mexico
[c] Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, Ciudad Universitaria, D.F. C.P. 04510, Mexico

ARTICLE INFO

Article history:
Received 4 May 2015
Received in revised form 20 July 2015
Accepted 22 July 2015

Keywords:
Gastrointestinal nematodes
Cattle
Resistance
Ivermectin
Veracruz Mexico

ABSTRACT

This study reports the percentage of cattle farms with ivermectin (IVM) resistant gastrointestinal nematodes (GINs) in Veracruz, Mexico, and identifies the GIN genera involved in the resistances. It also describes management practices of anthelmintic (AH) use on the surveyed farms. Twenty-one farms were assessed by means of the faecal egg count reduction test using the McMaster technique. Only two farms had GIN populations susceptible to IVM (9.5%). The proportion of farms with IVM resistant GIN was 71.4% (15/21). Seven of these farms had less than 80% egg count reductions. *Haemonchus* and *Cooperia* were the genera most commonly found in the resistant populations, followed by *Oesophagostomum*. Inappropriate AH treatment practices were identified from the completed questionnaires. Further management practices such as selective treatment and quarantine treatments are proposed to further reduce the spread of IVM resistance between farms.

1. Introduction

Ivermectin (IVM) and other macrocyclic lactones (ML) are the most common anthelmintic (AH) products used to control gastrointestinal nematodes (GIN) in cattle worldwide (Wolstenholme et al., 2004). However, the intensive and frequent use of this anthelmintic group has resulted in the development of IVM resistance in several hosts (McKellar and Jackson, 2004). Reports of ML resistance in GIN populations of cattle have emerged in several parts of the world. It is well known that the rapid development of GIN populations resistant to broad-spectrum AH drugs is an additional threat affecting the efficacy and sustainability of these important medications as parasite control tools (Leathwick et al., 2012). Thus, it is important for all countries to monitor the development and spread of resistant worm populations on different farms within a region or country.

In Mexico, the situation of ML resistance in GIN populations on cattle farms has been scarcely studied. The first report of resistance on cattle farms was generated recently for IVM in the hot humid tropics of Mexico (Encalada-Mena et al., 2008). Although the latter described the situation at only five farms where 100% frequency of IVM resistance was found, that survey stimulated the interest of other groups in Mexico to study the incidence of IVM resistance in other regions. A second report by Canul-Ku et al. (2012) in a sub humid hot tropical region in Mexico (Yucatán) also found a high frequency of IVM resistant GIN populations on cattle farms (11/14; 78.6%). These studies suggested the need to further investigate the situation of IVM resistance in other more humid tropical zones of Mexico such as Veracruz, the state of Mexico with the highest number of cattle (2,454,171 representing 10.5% of the national inventory) (INEGI, 2010). Cattle farmers in this area depend on grazing (Castillo-Gallegos et al., 2005) and, consequently, GINs represent an important threat to animal health in the region.

The objective of the present study was to estimate the percentage of cattle farms with GIN resistant to IVM in Veracruz, Mexico, including the identification of the genera involved and, to identify anthelmintic practices used on the surveyed farms.

* Corresponding author. Fax: +52 232 3243943.
E-mail addresses: alonsodm@unam.mx, alonsodma@hotmail.com (M.A. Alonso-Díaz).

http://dx.doi.org/10.1016/j.vetpar.2015.07.023
0304-4017/

2. Materials and methods

2.1. Study area and cattle farms selected

This study was carried out from January 2012 to April 2013 in five municipalities (Martinez de la Torre, Misantla, Nautla, Tlapacoyan and Vega de Alatorre) in the state of Veracruz, Mexico (24°4′N, 97°03′W). The climate is humid tropical with an average annual temperature of 23.4 ± 0.5 °C, annual rainfall of 1991 ± 392 mm and relative humidity of 85 ± 6%. Thirty-two cattle farms, where grazing is practiced, were included in the survey. However, only 21 farms were completely evaluated for AH resistance. Selection and sampling were made by convenience, i.e., not randomly selected.

At each farm, grazing calves 3–8 months old and 50–150 kg live weight were used. The inclusion criteria for farm selection were as follows: (i) herds with a population of calves (3–8 months of age), (ii) calves not dewormed during the last 60 days prior to the study, and (iii) herds with calves excreting greater or equal to 150 eggs per gram (EPG) of faeces (individual calf values not herd mean value) of the strongylida order. From a total of 1283 calves sampled from 32 herds, only 503 calves from 21 herds complied with the selection criteria. The major factor that limited the number of herds evaluated was the lack of animals with a faecal egg count (FEC) greater or equal to 150 EPG (even after visiting each farm on three or four occasions).

2.2. Experimental design to evaluate resistance

To diagnose the presence of GIN populations resistant to IVM, the Faecal Egg Count Reduction Test (FECRT), recommended by the World Association for the Advancement of Veterinary Parasitology was used (Coles et al., 1992). On day 0, within each farm, a sample of faeces was collected directly from the rectum of each calf (using a labeled plastic bag) to calculate the FEC. Faeces were transported in a plastic cooler (4–5 °C) to the Animal Health Laboratory for analysis. Faecal egg counts were determined using the modified McMaster technique with a sensitivity of 50 EPG (Rodríguez-Vivas and Cob-Galera, 2005). Coprocultures were made to identify the genus of GIN infective (L_3) larvae present in faeces. Then, on day 1, calves were distributed according to their parasite loads (balanced) into two experimental groups: a control group having 10–15 calves maintained without treatment and a treated group with 10 to 15 calves treated with IVM (Endectin®, Novartis, México; Reg. Sagarpa No. Q-0715-038) (intramuscular injection using a dose of 0.2 mg kg^{-1} live weight). Prior to treatment, animals were weighed individually using the same mobile weighing scale (TRU-TEST MP600®) so as to administer the correct dose of IVM, thereby avoiding variability among doses used for treatments. Fourteen days after treatment, another faecal sample was obtained from each calf to calculate the FEC as mentioned previously. A new coproculture per group was performed to identify the genus of GINs (L_3 stage) involved.

2.3. Questionnaire

A questionnaire was applied to every farm owner/manager to obtain information related to herd size, cattle breeds, production objective (dual purpose, milk or breeding stock), the family of AH currently used (ML, benzimidazole or imidazothiazole), frequency of AH treatments per year, correct dosage or not (e.g., animal weight measured or not), deworming new animals on arrival at farm and whether or not rotations of AH were used.

2.4. Statistical analysis

For each cattle farm, AH resistance was calculated following Coles et al. (1992) and RESO© software (CSIRO, 1990, Animal Health Division) by means of the formula:

$$\text{Percentage reduction} = \left(\frac{1-T}{C}\right) \times 100\%$$

where T is the FEC arithmetic mean of the treated group and C is the FEC arithmetic mean of the control group after treatment (at day 14).

The confidence interval (95%) was calculated by means of the RESO software. A cattle farm was considered to have resistant parasites when the FEC reduction percentage was <95% and the lower limit of the confidence interval was <90%. A population was considered suspect when the cattle farm complied with one of the two mentioned criteria and it was considered susceptible when none of the criteria was fulfilled.

A univariate analysis was performed using 2 × 2 contingency tables of exposure variables in Epi Info 3.5.3 (Center for Disease Control and Prevention, 2008) to estimate the association level with the response variables (susceptibility, low resistance or resistance to AHs). Exposure variables with P-values ≤0.20 were included in a logistic-binomial regression model (multivariate analysis) using Statgraphics 15.2.06 (StatPoint Inc., 2007). A P-value ≤0.05 was considered significant.

3. Results

3.1. Cattle farms with gastrointestinal nematodes resistant to ivermectin

Only two cattle farms had GIN populations susceptible to IVM (Table 1). The percentage of cattle farms with IVM resistant GIN was 71.4% (15/21). The percentage of FEC reduction on resistant farms varied from 0% to 93% (Table 1). Seven resistant farms had less than 80% of FEC reduction. The remaining 19% of cattle farms (4/11) were identified as suspect of IVM resistance.

3.2. Identified genera

On day 0, GIN infections on the cattle farms were evaluated and involved the following genera: *Haemonchus, Cooperia, Ostertagia* and *Oesophagostomum*, with the order of resistance to IVM being *Haemonchus*, *Cooperia* and *Oesophagostomum* (Table 2).

3.3. Questionnaire survey

The information related with anthelmintic practices used on the farms is shown in Table 3. In this study, 71.42% (15/21) of the cattle farms corresponded to dual-purpose system (milk and meat production). The most widely used family of AH was ML (85.71%; 18/21), followed by benzimidazole (47.61%; 10/21) and imidazothiazole, (28.57%; 6/21). All studied farms have used IVM for the control of GIN. Most producers do not weigh the animals before applying AH treatments (85.71%; 18/21). Also, most farmers mentioned they rotate between families of AH (90.5%; 19/21) and dewormed new animals on arrival (85.71%, 16/21). In this study, no factors were found to be associated with the presence of GIN populations resistant to IVM ($P > 0.05$).

4. Discussion

This study determined the percentage of cattle farms with GINs resistant to IVM. It showed a high prevalence of cattle farms with IVM resistant GIN. This is consistent with previous reports of ML