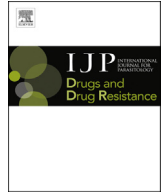




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Anthelmintic resistance in gastrointestinal nematodes of beef cattle in the state of Rio Grande do Sul, Brazil



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ABSTRACT

Gastrointestinal nematodes resistant to anthelmintics have been reported in several regions of Brazil, and they may be associated with economic losses for the cattle industry. This study aimed to evaluate the resistance status of gastrointestinal nematodes from naturally infected beef cattle to several commercially available anthelmintics, as well as to test the efficacy of combinations of anthelmintics against multi-resistant gastrointestinal nematodes. Ten farms located in Rio Grande do Sul state were selected by: farmers' consent; extensive raising system; availability of calves aged from 7 to 9 months naturally infected by gastrointestinal nematodes; absence of anthelmintic treatment for 60 days before the study; and presence of 70–100 calves or more of both genders with ≥ 200 eggs per gram of feces (EPG) (sensitivity of 50 EPG). These calves were distributed into 10 groups (of 7–10 animals) per farm and treated with ivermectin, doramectin, eprinomectin, fenbendazole, closantel, nitroxylin, disophenol, levamisole, albendazole, or moxidectin. Feces were collected 2 days before treatment and 14 days after treatment. Additional groups of 7–10 calves were used to test six different two-drug combinations at four of the studied farms. In general terms, fenbendazole was the most effective drug, followed by levamisole, disophenol, and moxidectin. However, parasite resistance to multiple drugs was found in all herds, especially in the genera *Cooperia* spp., *Trichostrongylus* spp., and *Haemonchus* spp.. Some of the two-drug combinations were effective against nematode populations identified as resistant to the same compounds when used as single drugs. The most effective combinations were moxidectin + levamisole, doramectin + fenbendazole, and levamisole + closantel. In this study, parasites resistant to the main commercially available anthelmintics were found in all herds, and some combinations of two active components belonging to different chemical groups were effective against multi-drug resistant gastrointestinal nematodes.

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1. Introduction

The cattle industry is one of the largest sectors of the Brazilian economy. Brazil is the world's second largest producer of cattle, with a total herd of 217.4 million head (FAO, 2014; Cider, 2014). Recently, the cattle industry has experienced a rise in intensity and productivity, as shown by a 50% increase in occupancy rate (animal/

hectare) and a 3.4% decrease in pasture area from 1990 to 2011 (INSTITUTO FNP, 2012). Particularly in the state of Rio Grande do Sul, beef cattle production occurs predominantly on native pastures, often without considering the effects on sustainability (Beretta et al., 2002) and the environmental changes caused by increased population density and restriction of livestock movement. In addition, genetic selection for desired production characteristics has led to changes in the natural parasite/host balance, resulting in increased susceptibility of cattle to parasites (Waller, 2002).

Infections by gastrointestinal nematodes affect the well-being

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and productivity of hosts, causing decreased reproductive performance, a low growth rate, weight loss, and poor food conversion (Mello et al., 2006; West et al., 2009; De Graef et al., 2013). In Brazil, anthelmintics are generally used at farmers' discretion, with no restrictions to access to commercially available drugs and without any assistance from veterinarians. Thus, inadequate use of anthelmintics is not rare; indeed, animals are often treated excessively, interfering with production, accelerating selection of resistant parasites, and posing significant problems for the cattle industry (Delgado et al., 2009; Zanetti Lopes et al., 2013).

Parasite resistance has gradually become a significant problem facing cattle producers in several regions worldwide, including Brazil (de Souza et al., 2008; Demeler et al., 2009). Limited information exists regarding parasite resistance status in local cattle herds in the Brazilian state of Rio Grande do Sul; however, there is strong evidence that gastrointestinal nematodes infecting Brazilian herds have gained resistance to the main available classes of anthelmintics (Soutello et al., 2007; Cezar et al., 2010b; Borges et al., 2013; Neves et al., 2014).

This study aimed to verify the existence of populations of gastrointestinal nematodes resistant to several commercially available anthelmintic compounds by evaluating naturally infected beef cattle from herds located in the state of Rio Grande do Sul, Brazil. In addition, the efficacies of some two-drug combinations were tested to assess their potential as alternative to control the multi-drug resistant parasite populations found in the studied herds.

2. Material and methods

2.1. Farms and animals

The study was conducted on ten farms located in eight counties of the Rio Grande do Sul state in southern Brazil: São Martinho da Serra, Dilermando de Aguiar (two farms), Cacequi (two farms), São Gabriel, Itaqui, São Borja, Santiago, and São Vicente do Sul (Fig. 1).

Preliminarily, herds were selected based on location and previous consent by farmers. Additionally, the following technical criteria were considered: the extensive system used to raise beef cattle; the availability of *Bos taurus/Bos indicus* crossbred calves of both genders (aging from 7 to 9 months); the presence of 70–100 calves or more per farm with counts of ≥ 200 eggs per gram of feces (EPG); and the absence of anthelmintic treatment for 60 days before the experimental period. First, all calves available at each farm were included in the study; however, animals with fewer than 200 EPG before treatment were excluded prior to the formation of the experimental groups. Calves were weaned approximately six months after birth and kept in the same grazing area before and during the study on each farm. The use of animals was approved by the Committee of Ethics in Animal Experimentation of the Federal University of Santa Maria under protocol no. 3132240215.

2.2. Anthelmintic treatment

In the first part of the study, ten commercially available anthelmintic compounds were tested on each farm. All treatments were administered by a veterinarian participant of the study following the manufacturer's recommendations: ivermectin 1% (0.2 mg/kg, subcutaneous, Hipramectin[®] HIPRA), doramectin 1% (0.2 mg/kg, subcutaneous, Dectomax[®] Zoetis), eprinomectin 0.5% (500 µg/kg, pour-on, Eprinex[®] Merial), moxidectin 1% (0.2 mg/kg, subcutaneous, Cydectin[®] Ford Dodge), levamisole 7.5% (3.75 mg/kg, subcutaneous, Ripercol L[®] Fort Dodge), albendazole 15% (3.4 mg/kg, subcutaneous, Agebendazol[®] Gener), nitroxylnil 34% (9.7 mg/kg, subcutaneous, Dovenix Supra[®], Merial), disophenol 20% (5 mg/kg, subcutaneous, Pradoverme[®] PRADO), fenbendazole 10% (5 mg/kg, oral, Panacur[®] Intervet), and closantel 10% (10 mg/kg, oral, Diantel[®] HIPRA).

After determining the efficacy of each single anthelmintic treatment, six combinations of two drugs were tested at four of the ten farms as a second part of this study. For this purpose, new groups of calves, selected by the criteria described before, were

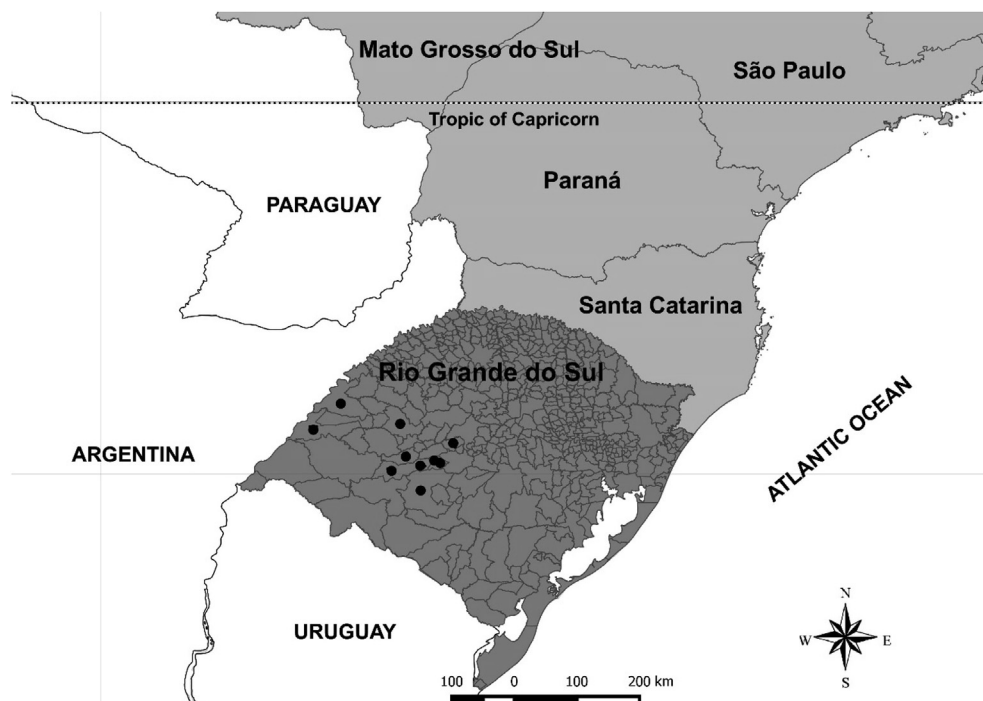


Fig. 1. Location of ten beef cattle herds studied at eight counties from the state of Rio Grande do Sul in southern Brazil. The black spheres indicate the locations of the farms.

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