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The effect of risk factors of sheep flock management practices on the development of anthelmintic resistance in the Czech Republic

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ABSTRACT

The in vivo faecal egg count reduction test was used for the evaluation of the benzimidazole and macrocylic lactone drug efficacies against gastrointestinal nematodes in 10 flocks of sheep. The same samples were tested concurrently in vitro for benzimidazole resistance using the egg hatch test, and for resistance to ivermectins using the microagar larval development test. The conformity of obtained results between in vivo and in vitro tests was recorded. When the selected methods were applied, anthelmintic resistance to benzimidazoles was detected at four (40%) farms while resistance to ivermectins was evident at one (10%) farm. At one farm (10%) ivermectin resistance was suspected. Moxidectin was effective at all surveyed farms. *Teladorsagia* was recognized as the only benzimidazole resistant genus in post-treatment coprocultures, whereas *Haemonchus* larvae were resistant to ivermectins. This represents the first recorded occurrence of ivermectin resistance in gastrointestinal nematodes of sheep in the Czech Republic. A linear mixed-effects model demonstrated that the majority of evaluated management practices have a significant effect on resistance to benzimidazoles. While application of preventive practices like quarantine and smart drenching maintains low levels of anthelmintic resistance, others like the dose-and-move strategy, administration of the same family of drugs over extended periods of time, and number of treatments per year are responsible for the increase of resistance to anthelmintics at evaluated farms. Only targeted selective treatments approaches had no effect on resistance status. This study indicates the importance of farm management practices in anthelmintic resistance development.

1. Introduction

Parasitic gastroenteritis represents a major health problem as well as economic losses in the small ruminant industry worldwide. The control of gastrointestinal nematodes (GINs), which are causative agents of parasitic gastroenteritis, is based primarily on anthelmintic drugs and management practices. However, heavy reliance on anthelmintics and their widespread use select GINs able to tolerate a drug dose that is effective against common populations of nematodes. This anthelmintic resistance (AR) has emerged globally in the sheep and goat industry, and there are currently farms in South Africa and Australia where resistance has become such a serious problem that farming is no longer possible (van Wyk et al., 1989; Sangster and Dobson, 2002; Sutherland and Scott, 2010). Until now, GIN resistance to all major families of broad-spectrum anthelmintics has been detected (Wolstenholme et al., 2004; Cezar et al., 2010). Moreover, multiple resistance to several anthelmintic families has been steadily

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increasing, particularly in countries in the Southern hemisphere (van Wyk et al., 1999; Chandrawathani et al., 2004; Sutherland et al., 2008; Fiel et al., 2011; Veríssimo et al., 2012; Chagas et al., 2013). The status quo in Europe is not so untenable; however, cases of AR have been reported from most European countries (Borgsteede et al., 1997; Bartley et al., 2003; Čerňanská et al., 2006; Taylor et al., 2009; Papadopoulos et al., 2012).

It is generally accepted that resistant genes spread through natural nematode populations, and AR evolves when selection pressure on these nematodes is high (Sangster and Dobson, 2002; Coles, 2005; Sutherland and Scott, 2010). AR evolves rapidly (Wolstenholme et al., 2004), and resistant genes persist in nematode populations for many generations (Palcy et al., 2010). The reversion of these resistant nematodes to susceptibility status is theoretically possible; however, there have been no reports of full reversion in the field to date. Therefore, preventive strategies that slow the development of resistance should be integrated into each breeding management. These strategies include quarantine treatment of incoming animals with two broad spectrum drugs from different anthelmintic families, turning out treated animals to pasture lightly contaminated with nematode eggs and larvae (Fleming et al., 2006; Abbott et al., 2012) and using smart drenching approach to treat only animals that will most benefit from this medicate, so-called targeted selective treatments (Jackson et al., 2009; Kenyon et al., 2009). Moreover, environmental measures including pasture management and weather conditions at a specific farm should also be taken into consideration (Silvestre et al., 2002; Fleming et al., 2006).

Our objective was to evaluate the efficacies of three anthelmintic drugs at selected Czech sheep farms that implement different breeding management and treatment practices, and subsequently to assess the effect of selected risk factors on AR development at these farms.

2. Materials and methods

Altogether 16 sheep farms from different parts of the Czech Republic were visited, and information on farm management strategies practised on these farms was obtained. Of these 16 farms, only ten fulfilled selection criteria, after which their owners agreed to participate in the 2012 study. The major farm management practises evaluated in this study were as follows: (1) treatment of all incoming animals (quarantine); (2) smart drenching approach, which involved weighing animals prior to treatment, correct drug application according to the manufacturer's recommendations, withholding food 24 h prior to drenching and repeated drenching 12 h after the first dose of short acting drugs; (3) drenching only animals that need treatment (targeted selective treatment); (4) using the same anthelmintic drug family in consecutive years; (5) treatment frequency per year; (6) dosing animals with anthelmintics before placing them on the field – the so-called dose and move strategy. Only farmers who follow all recommendations for the smart drenching approach listed above were evaluated as "smart drenching farmers". Faecal consistency was used by farmers as a pathophysiological indicator for the TST approach (see Table 1).

Before initiation of the study, animals on selected farms were examined using the modified Concentration McMaster technique (Roepstorff and Nansen, 1998) with a detection limit of 20 eggs per gram (EPG). Only animals with an EPG of ≥150 were included in the experiment. Sheep from the evaluated farms did not receive any anthelmintic treatment for at least eight weeks prior to the initiation of the study; our study was the first to use moxidectin at these farms. Thirty animals (4–6 months of age) were randomly selected from each farm and divided into three groups of

Table 1
Farm management practises evaluated in relation to anthelmintic resistance.

Farm info Management system	Farm 01 Ecological	Farm 02 Conventional	Farm 03 Conventional	Farm 04 Conventional	Farm 05 Ecological	Farm 06 Conventional	Farm 07 Conventional	Farm 08 Conventional	Farm 09 Conventional	Farm 10 Conventional
Quarantine new animals	No [a]	Yes	Yes	No	Yes	Yes	No	No	No	Yes
Smart drenching approach	Yes	No	Yes	Partly	Yes	No	Yes	Yes	No	Yes
Targeted Selective Treatments	Yes	No	No	No	Yes	No	Yes	No	Yes	No
Using same drug class in years	(BZs) 1	(BZs) 5	(AVMs) 4	(BZs/AVMs) 4	(BZs) 3	(BZs) 5	(BZs) 3	(BZs) 3	(BZs) 4	(AVMs) 1
Treatment frequency per year	2	4	3	4	2	4	3	4	6	3
Dose-and-move strategy	No	Yes	No	Yes	No	No	No	Yes	Yes	No

[a] A closed flock turnover, benzimidazole (BZ), avermectin (AVM) and moxidectin (MOX).