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The maintenance of anthelmintic efficacy in sheep in a Mediterranean climate

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ABSTRACT

To determine how far management practices on small ruminant dairy flocks in southern Italy have influenced the development of anthelmintic resistance (AR), faecal egg count (FEC) reduction tests were run on 54 sheep farms using the FLOTAC technique with a sensitivity of 2 eggs per gram of faeces. Tests were run on groups of sheep (12–20 animals per group) using six anthelmintics administered orally: levamisole on 8 farms, ivermectin (half and full dose) on 8 farms, moxidectin on 3 farms, monepantel on 8 farms, netobimin on 22 farms (pooled samples) and albendazole on 5 farms (pooled samples). Different formulae and statistics were used to calculate FEC reductions and confidence intervals based on the presence of a control group and/or the use of pooled samples. A very high average efficacy was obtained with all anthelmintics tested as follows: levamisole 99.3% (range across farms 98–100%), ivermectin half dose 99.5% (98.0–100%), ivermectin full dose 99.9% (99.3–100%), moxidectin 100% (99.9–100%), monepantel 99.4% (97–100%), netobimin 99.1% (92–100%) and albendazole 100%. The results suggest that the development of AR in small ruminants could be limited in countries with a Mediterranean type of climate provided that refugia of the nematode populations are maintained, anthelmintic use is restricted and movement of animals is not permitted to spread resistance.

1. Introduction

Anthelmintic resistance has become an urgent global issue in the control of nematodes of sheep and goats in major small ruminant producing regions, e.g. South America, Australasia, South Africa and the UK, with multiple resistance found on many farms. This is particularly true where *Haemonchus contortus* is the dominant species in summer rainfall areas. There is relatively little information on what is happening in sheep flocks in countries with a Mediterranean type climate, i.e. hot dry summers and cooler moist winters, with the exception of Greece (Papadopoulos et al., 2001) where mixing of flocks on mountain pastures may slow the development of resistance, and Algeria where benzimidazole resistance was found on five out of 14 pilot farms and ivermectin resistance on one (Bentounsi et al., 2007). However, in south-western Australia which also has a Mediterranean type climate resistance has been developing very rapidly (Suter et al., 2005). The climate in central and southern Italy is typically Mediterranean and in central Italy resistance to imidazothiazole and macrocyclic lactones was found in trichostrongylids on a number of sheep farms (Traversa

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et al., 2007). In addition one case of benzimidazole resistance has been reported in *Trichostrongylus colubriformis* on a goat farm (Cringoli et al., 2007). In the southern regions of Italy sheep are kept for milk production with anthelmintic treatments usually being given only twice per year to lambs (Cringoli, personal communication, 2013) and adults being left untreated during lactation (Cringoli et al., 2008, 2009). Since these practices ought to leave abundant helminths *in refugia* for susceptible genotypes, and this is believed to be the most important issue in the development of anthelmintic resistance (Van Wyk, 2001), there should have been little development of resistance on farms using this system.

In the present study the presence of anthelmintic resistance was investigated on 54 farms using the faecal egg count reduction test (FECRT) following the recommendations of Coles et al. (1992) on flocks of sheep using four groups of anthelmintics (benzimidazoles, levamisole, ivermectin/moxidectin and monepantel) and the FLOTAC technique having a sensitivity of 2 eggs per gram of faeces (Cringoli et al., 2010). The aim was to determine whether management practices in this region have allowed the maintenance of anthelmintic efficacy.

2. Materials and methods

2.1. Study area

The study was conducted in the Campania region of southern Italy. In this area, sheep farms are widely distributed with an average area of approximately 50 ha. The area is mainly used for cereal production but small pastures occur on upland areas that are unsuitable for cropping.

2.2. Study farms and animals

Trials were conducted between 2008 and 2011 on 54 sheep farms.

Dairy sheep farms were randomly selected throughout the region and the selection was mainly driven by the availability of the farmer. The animals used for the trials were mainly local regional breeds, e.g. Bagnolese (for milk) and dairy crossbreeds (e.g. Comisana × Sarda). These animals were kept on the pasture all year round.

The anthelmintic classes, drugs and dose as well as the number of farms and animals used in the study are given in Table 1. On each farm all animals were weighed and given the correct dose. With ivermectin a half dose was also included to indicate whether resistance to the macrocyclic lactones might be developing (Palmer et al., 2000). Tests were run with groups of sheep (12–20 animals per group) using six anthelmintics administered orally, levamisole (Levacide, Norbrook, 7.5 mg/kg) on 8 farms, ivermectin (Oramec, Merial, 0.1 and 0.2 mg/kg) on 8 farms, moxidectin (Cydectin, Pfizer, 0.2 mg/kg) on 3 farms, monepantel (Zolvix, Novartis, 2.5 mg/kg) on 8 farms, netobimin (Hapadex, Intervet, 7.5 mg/kg) on 22 farms (pooled samples) and albendazole (Sverminator/Valbazen, Fatro/Pfizer 3.8 mg/kg) on 5 farms (pooled samples). Pooled samples were used where the presence of benzimidazoles was being investigated so that more farms could be surveyed (Rinaldi

Table 1
The anthelmintics (class, drugs and dosages) used on sheep farms (no. of farms, animals and presence of a control group) in southern Italy. Mean GI strongyle EPG and activity of netobimin, albendazole, levamisole, ivermectin, moxidectin and monepantel against GI nematodes calculated by the four methods (FECR1, FECR2, FECR3 and FECR4).

Anthelmintics			Farm characteristics			Day 0 FEC (mean epg)		Day 7 FEC (mean epg)		Day 14 FEC (mean epg)		The activities calculated by the different methods: min and max FECR (min and max lower confidence limits)			
Class[a]	Molecule	Dosage of drug (mg/kg)	No. of sheep farms tested	No. of animals per treatment	Presence of a control group	Control group	Treated group	Control group	Treated group	Control group	Treated group	FECR1	FECR2	FECR3	FECR4
BZ/PBZ	Netobimin	7.5	22 (April, 2008)	20 (pooled)	No	–	505.0	–	–	–	4.8	–	–	92.0–100	92.0–100 (85.9–99.9)
	Albendazole	3.8	5 (March, 2008)	20 (pooled)	No	–	257.4	–	–	–	0	–	–	100	100 (94.4–98.3)
LV	Levamisole	7.5	8 (August, 2009)	12	Yes	425.4	372.7	353.6	1.9	–	–	98.3–100 (92.2–98.8)	98.3–100 (92.0–99.3)	–	98.5–100 (97.4–99.9)
ML	Ivermectin	0.2	8 (March, 2009)	12	Yes	218.0	302.4	–	–	148.5	0.6	99.5–100 (95.5–98.8)	99.6–100 (97.0–99.6)	–	99.7–100 (98.6–99.9)
	Ivermectin	0.1	8 (June, 2009)	12	Yes	218.0	283.2	–	–	148.5	0.3	98.8–100 (90.2–98.8)	98.0–100 (90.4–99.6)	–	96.4–100 (93.4–99.9)
	Moxidectin	0.2	3 (October, 2010)	20	Yes	618.3	550.6	–	–	306.3	0.2	99.9–100 (99.1–99.4)	99.9–100 (99.5–99.6)	–	99.9–100 (99.8–99.9)
AAD	Monepantel	2.5	8 (August, 2011)	12	Yes	425.4	509.3	353.6	2.4	–	–	97.3–100 (94.9–99.4)	97.8–100 (95.7–98.5)	–	97.0–100 (96.1–99.8)

[a] BZ/PBZ, benzimidazoles/probenzimidazoles; LV, imidazothiazoles/tetrahydropyrimidines; ML, macrocyclic lactones; AAD, amino acetonitrile derivates.