



Detection of Multiple Anthelmintic Resistance in Unorganized Goat Farms

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ABSTRACT

Two unorganized goat farms from the dry sub-humid zone of Sirsa, Haryana were surveyed to determine the efficacy of fenbendazole, closantel, and ivermectin against gastrointestinal nematodes using the faecal egg count reduction test (FECRT). A total of 120 goats, 60 each from Bhawdin (BV) and Rattakhera (RV) villages, with a minimum of 150 eggs per gram (EPG) of faeces, were selected. Animals were divided into four groups of 15 goats each per farm. Groups B1 and R1 were treated with fenbendazole @ 10 mg/kg b.wt. orally, groups B2 and R2 with closantel @ 20 mg/kg b.wt. orally, groups B3 and R3 with ivermectin @ 0.4 mg/kg b.wt., subcutaneous, while groups B4 and R4 served as untreated controls. Faecal samples were collected on day 0 and day 14 post-treatment, and egg counts were determined using the Modified McMaster technique. Percent reduction in faecal egg counts in BV was 62.02, 88.03, and 75.50 for fenbendazole, closantel, and ivermectin, respectively, while in RV it was 55.21, 84.84, and 87.07. Post-treatment coproculture revealed predominance of *Haemonchus contortus* larvae in both farms. The findings confirm the presence of multiple anthelmintic resistance, with fenbendazole showing moderate resistance and closantel and ivermectin exhibiting reduced efficacy. This highlights the urgent need for regular monitoring, strategic drug rotation, and judicious use of anthelmintics to sustain effective parasite control in goat farms of Sirsa, Haryana.

Keywords: Anthelmintic resistance, Closantel, Fenbendazole, Haryana, Ivermectin Goat.

INTRODUCTION

Goat farming plays a vital role in the livelihood of small and landless farmers in India due to low input requirements, quick returns, and adaptability to diverse agro-climatic conditions (Tiwari *et al*, 2014; Singh and Sharma, 2019). In Haryana, the goat population is approximately 0.335 million (DAHD, 2020). However, gastrointestinal nematodes (GINs) remain a major constraint to productivity, causing significant morbidity and mortality. Among these, *Haemonchus contortus* is the most pathogenic and widely prevalent species, responsible for severe economic losses in small ruminants (Yadav *et al*, 1995; Kaplan and Vidyashankar, 2012). Chemical control using anthelmintics has been the cornerstone of parasite management for decades. Commonly used drugs include benzimidazoles (e.g., fenbendazole), salicylanilides (e.g., closantel), and macrocyclic lactones (e.g., ivermectin). However, frequent, indiscriminate use and underdosing have accelerated the emergence of anthelmintic resistance (Coles *et al*,

1992; Kumar and Yadav, 1994; Rialch *et al*, 2013). Reports of multiple drug resistance in *H. contortus* have been documented across India (Chandra *et al*, 2015; Sharma *et al*, 2015; Kumar and Singh, 2016; Dixit *et al*, 2017) and globally (Silvestre and Humbert, 2000; Von Samson-Himmelstjerna *et al*, 2009; Arsenopoulos *et al*, 2020; Kapo *et al*, 2024). Recent molecular and field studies confirm that benzimidazole resistance is widespread, with mutations in β -tubulin genes serving as key markers (Tiwari *et al*, 2006; Dolinska *et al*, 2023; Bhagat *et al*, 2024; Reyilanmu Tuerhong *et al*, 2024; Curi *et al*, 2025; Helal *et al*, 2025; Pelantova *et al*, 2025). Similar resistance trends have been reported for closantel and ivermectin, with reduced efficacy observed in India (Garg *et al*, 2007; George *et al*, 2011; Maharshi *et al*, 2011; Vohra *et al*, 2013) and abroad (Pena-Espinoza *et al*, 2014; Macedo *et al*, 2023; Kaur *et al*, 2025). The persistence of resistant nematode populations even in the absence of drug pressure (McKenna, 1990; Webb *et al*, 1979) underscores the need for regular monitoring. Updated WAAVP guidelines recommend faecal egg count

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reduction tests (FECRT) as a standard tool for assessing drug efficacy (Coles *et al*, 2006; Ray *et al*, 2023).

MATERIALS AND METHODS

The present investigation was carried out in goats reared under unorganized farming systems in the dry sub-humid zone of Sirsa, Haryana. Two villages, Bhawdin (BV) and Rattakhera (RV), were selected to evaluate the efficacy of fenbendazole, closantel, and ivermectin against gastrointestinal nematodes using the faecal egg count reduction test (FECRT) as recommended by the World Association for the Advancement of Veterinary Parasitology (Coles *et al*, 1992; Coles *et al*, 2006; Ray *et al*, 2023). A total of 120 goats, 60 from each village, naturally infected with nematodes and showing faecal egg counts (EPG) greater than 150 were included in the study. None of the animals had received anthelmintic treatment during the preceding two months. Each goat was identified, weighed, and its baseline faecal egg count was determined using the Modified McMaster technique, with one egg representing 50 EPG (Van Wyk and Mayhew, 2013).

The animals from each farm were randomly divided into four groups of 15 goats each. In BV, groups B1, B2, and B3 were treated with fenbendazole (@ 10 mg/kg body weight orally, Panacur®, MSD), closantel (@ 20 mg/kg body weight orally, Zycloz®, Zydus), and ivermectin (@ 0.4 mg/kg body weight subcutaneously, Zenvet®, INTAS), respectively, while group B4 served as untreated control. Similarly, in RV, groups R1, R2, and R3 received fenbendazole, closantel, and ivermectin at the same dosages, while group R4 served as untreated control. Faecal samples were collected from all animals on day 0 and day 14 post-treatment, and egg counts were determined to assess drug efficacy.

Pooled faecal cultures from each group were incubated at 27 ± 2 °C for seven days to recover infective third-stage larvae (L3). The larvae were identified morphologically according to the criteria described by Keith (1953) and Van Wyk and Mayhew (2013). The percentage reduction in faecal egg counts and 95% confidence intervals was calculated following WAAVP guidelines. Anthelmintics were considered fully effective when the reduction exceeded 95% with lower confidence limits above 90%, moderately resistant when reduction ranged between 60–95% with lower confidence limits below 90%, and severely resistant when reduction was below 60% with lower confidence limits under 90%. All data were statistically analyzed using one-way ANOVA with SPSS software version 27.0.

RESULTS AND DISCUSSION

The faecal egg counts (Mean $\pm$ S.E.) on day 0 and day 14 post-treatment, percent reduction in faecal egg counts (FECRT%), variance, and confidence limits (95%) for fenbendazole, closantel, and ivermectin in goats naturally infected with gastrointestinal nematodes at Bhawdin (BV) and Rattakhera (RV) villages of Sirsa are presented in Tables 1 and 2. In BV, fenbendazole reduced faecal egg counts by 62.02%, closantel by 88.03%, and ivermectin by 75.50%. In RV, the corresponding reductions were 55.21%, 84.84%, and 87.07%, respectively. These results indicate moderate resistance against fenbendazole in both villages, while closantel and ivermectin showed reduced efficacy, consistent with moderate resistance. The pooled faecal cultures revealed predominance of *Haemonchus contortus* larvae in both BV and RV farms before and after treatment (Table 3). Minor proportions of *Trichostrongylus spp.*, *Oesophagostomum spp.*, and *Strongyloides spp.* were present on day 0 but disappeared after treatment, leaving only *H. contortus*. This finding is in agreement with earlier reports from Haryana and other parts of India, where *H. contortus* has been identified as the most pathogenic and resistant nematode species (Yadav *et al*, 1995; Rialch *et al*, 2013; Chandra *et al*, 2015; Sharma *et al*, 2015).

The resistance observed against fenbendazole in Sirsa farms may be attributed to frequent and prolonged use of benzimidazoles, often without accurate body weight estimation, leading to underdosing. Similar persistence of resistant populations has been reported previously, even in the absence of drug pressure (Webb *et al*, 1979; McKenna, 1990). The moderate resistance to closantel and ivermectin observed in BV and RV is consistent with earlier findings from India and abroad (Garg *et al*, 2007; George *et al*, 2011; Maharshi *et al*, 2011; Pena-Espinoza *et al*, 2014; Macedo *et al*, 2023). The predominance of *H. contortus* after treatment further confirms its role in the development of multiple anthelmintic resistance. Globally, similar resistance trends have been reported, with benzimidazole resistance confirmed through molecular markers such as β -tubulin mutations (Silvestre and Humbert, 2000; Tiwari *et al*, 2006; Dolinska *et al*, 2023; Bhagat *et al*, 2024; Helal *et al*, 2025). The present findings from Sirsa align with these reports, highlighting the widespread nature of resistance in small ruminant nematodes. Overall, the study demonstrates that fenbendazole has lost substantial efficacy, while closantel and ivermectin are showing moderate

Detection of Multiple Anthelmintic Resistance in Unorganized Goat Farms

Table 1: Response to various anthelmintics in goats naturally infected with gastrointestinal nematodes at Bhawdin Village, Sirsa

Group	Anthelmintic	Dose (mg/kg)	No. of goats treated	Route of administration	Faecal egg counts on days (Mean $\pm$ S.E.)		Faecal egg counts reduction on day 14 post-treatment		Confidence limits at 95%	
					0	14	%	Variance	Upper	Lower
I	Fenbendazole	10	15	Oral	604 ^a $\pm$ 114.45	190 ^b $\pm$ 93.72	62.02	0.08	79.51	32.34
II	Closantel	20	15	Oral	606 ^a $\pm$ 111.74	74.98 ^b $\pm$ 25.18	88.03	0.13	94.05	66.24
III	Ivermectin	0.4	15	S/C	614.22 ^a $\pm$ 134.44	122.34 ^b $\pm$ 38.37	75.50	0.03	56.59	47.81
IV	Control	---	15	---	608.77 ^a $\pm$ 87.34	477.77 ^a $\pm$ 65.06	0	---	---	---

Means with same superscripts in column are not significantly different ($p < 0.05$)

Table 2: Response to various anthelmintics in goats naturally infected with gastrointestinal nematodes at Rattakhera village, Sirsa

Group	Anthelmintic	Dose (mg/kg)	No. of goats treated	Route of administration	Faecal egg counts on days (Mean $\pm$ S.E.)		Faecal egg counts reduction on day 14 post-treatment		Confidence limits at 95%	
					0	14	%	Variance	Upper	Lower
I	Fenbendazole	10	15	Oral	704.56 ^a $\pm$ 73.46	235.33 ^b $\pm$ 88.61	55.21	0.15	81.87	52.13
II	Closantel	20	15	Oral	709.66 ^a $\pm$ 91.47	107.86 ^b $\pm$ 39.11	84.84	0.32	94.12	53.14
III	Ivermectin	0.4	15	S/C	733.23 ^a $\pm$ 49.53	121 ^b $\pm$ 57	87.07	0.13	91.82	74.84
IV	Control	---	15	---	703 ^a $\pm$ 29.85	577.63 ^a $\pm$ 77.51	0	---	---	---

Means with same superscripts in column are not significantly different ($p < 0.05$)

Table 3: Effect of anthelmintics on different genera of gastrointestinal nematodes of goats at Bhawdin and Rattakhera village, Sirsa

Group	Species	Bhawdin		Rattakhera	
		Per cent larval composition on day		Per cent larval composition on day	
		0	14	0	14
I-Fenbendazole	<i>Haemonchus</i> spp.	85	100	81	100
	<i>Trichostrongylus</i> spp.	5	0	9	0
	<i>Oesophagostomum</i> spp.	6	0	5	0
	<i>Strongyloides</i> sp.	4	0	5	0
II-Closantel	<i>Haemonchus</i> spp.	79	100	83	100
	<i>Trichostrongylus</i> spp.	6	0	7	0
	<i>Oesophagostomum</i> spp.	1	0	5	0
	<i>Strongyloides</i> sp.	4	0	5	0
III-Ivermectin	<i>Haemonchus</i> spp.	77	100	93	100
	<i>Trichostrongylus</i> spp.	11	0	2	0
	<i>Oesophagostomum</i> spp.	3	0	2	0
	<i>Strongyloides</i> sp.	9	0	3	0
IV-Control	<i>Haemonchus</i> spp.	77	88	86	96
	<i>Trichostrongylus</i> spp.	3	2	5	2
	<i>Oesophagostomum</i> spp.	7	1	6	1
	<i>Strongyloides</i> sp.	3	9	3	1

resistance in goat farms of Sirsa. The persistence of *H. contortus* as the predominant species underscores the urgent need for regular monitoring, strategic drug rotation, and integrated parasite management practices to sustain effective control.

CONCLUSION

The present study revealed the occurrence of multiple anthelmintic resistance in goats from Bhawdin and Rattakhera villages of Sirsa, Haryana.

Fenbendazole showed moderate resistance with reduced efficacy, while closantel and ivermectin also demonstrated moderate resistance, indicating that none of the commonly used drugs achieved full effectiveness against gastrointestinal nematodes. Post-treatment coproculture confirmed *Haemonchus contortus* as the predominant species responsible for resistance, with minor genera disappearing after treatment. These findings are in agreement with earlier reports from India and abroad, highlighting the persistence and pathogenicity of *H. contortus* in small

ruminant populations. The results emphasize the urgent need for regular monitoring of drug efficacy, adherence to WAAVP guidelines for FECRT, and judicious use of anthelmintics to delay further resistance development. Strategic drug rotation, accurate dosing based on body weight, and integration of non-chemical parasite control measures should be prioritized to sustain effective gastrointestinal nematode management in goat farms of Haryana. This study provides the first evidence of multiple anthelmintic resistance in unorganized goat farms of Sirsa, underscoring the importance of vigilance and adaptive parasite control strategies in the dry sub-humid zone.

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Detection of Multiple Anthelmintic Resistance in Unorganized Goat Farms

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