Scholars Journal of Agriculture and Veterinary Sciences (SJAVS) **e-ISSN 2348–1854**
Abbreviated Key Title: Sch. J. Agric. Vet. Sci. **p-ISSN 2348–8883**

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Efficacy of Copper Oxide Wire Particles against Predominant Gastrointestinal Nematodes of Indigenous Goats in Kenya

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Original Research Article

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Article History
Received: 22.11.2017
Accepted: 26.11.2017
Published: 30.12.2017

DOI:
10.21276/sjavs.2017.4.12.2

Abstract: An 8 week study was undertaken to determine the therapeutic efficacy of copper oxide wire particles (COWP, Copinox®, Animax Ltd, UK) against mixed gastrointestinal nematodes of naturally infested indigenous goats in a semi-arid area of eastern Kenya. Forty five small East African goats, of mixed sexes and an average age of 7 months were randomly assigned into 3 groups of 15 animals based on fecal egg counts (FEC). Group I goats were given orally a 2 g COWP capsule each, group II received a 2 g COWP capsule and Curazole® (Fenbendazole) at a dose rate of 5 $mgkg^{-1}$ body weight and group III (control) were left untreated. Parameters measured included, weekly FEC, fecal cultures and worm counts on study termination (day 56). There was a significant ($p < 0.05$) drop of FEC for group I (COWP) relative to group III from day 0 up to day 28 post-treatment. Group II (COWP + Curazole®) FEC remained consistently lower ($p < 0.05$) than those of group I from day 7 up to day 35 post-treatment. Percent FEC reduction from day 7 to 35 for COWP group was: days 7 (85.3%); 14 (93.4%), 21 (81%), 28 (58%) and 35 (30%) relative to COWP plus CUZ group which were: days 7 to 21 (100%), day 28 (87.8%) and day 35 (73.9%), respectively. From day 42 to 56, FEC were not significantly different ($p > 0.05$) between the 3 experimental groups. Fecal cultures showed that COWP was only effective against *Haemonchus spp.* with nil efficacies against *Trichostrongylus spp*. and *Oesophagostomum spp*. infestations. Curazole® was effective against all the three strongylid species. On necropsy, mean worm count of H. contortus were reduced in group I by 58.8% (mean = 680) and in group II by 68.1% (mean = 526) compared to the control group (mean 1650 ($p < 0.05$)). Results demonstrated that administration of COWP had a significant anthelmintic effect on pre-existing H. contortus infestation and represent an alternative to conventional anthelmintics in control of this worm especially where anthelmintic resistance is widespread in goat farms

Keywords: Anthelmintic resistance, copper oxide wire particles, fenbendazole, Haemonchus contortus, nematodes.

INTRODUCTION

Nematodes induced parasitic gastroenteritis is one of the major constraints to profitable small ruminant production in tropical and subtropical regions of the world [1] including the low rainfall agro-climatic zones of Kenya [2]. It has been estimated that *Haemonchus contortus* alone causes losses in the order of US$ 26 million each year [3]. The control of nematodosis in small ruminants is primarily based on the use of anthelmintics but now severely impaired by increasing development of anthelmintic resistance (AR) to the available anthelmintics [4-7]. As a consequence, considerable research effort has been expended on alternative control strategies which include the use of copper oxide wire particles (COWP) [8-10]. These particles have an anthelmintic effect against the abomasal nematode, *H. contortus* [11] and represent a potentially cheap alternative to conventional anthelmintics for small-scale farmers in the developing world, if they can be successfully integrated into worm control strategies [12, 13]. The anthelmintic efficacy of COWP against *H. contortus* has been reported under temperate and sub-tropical environments [10, 14-16]. However, no information is available on its application to small ruminants in Kenya. The objective of the present study was to determine the therapeutic efficacy of COWP against predominant gastrointestinal (GI) nematodes of indigenous goats in a semi-arid area of Kenya.

MATERIALS AND METHODS

Study area

This study was conducted on a farm in Katani area of Kathiani sub-county, Machakos County, Kenya. The local climate is semi-arid with hilly terrain and lies at an average altitude of 1200 m above sea level. The

area receives a mean annual rainfall of between 500 and 1000 mm. The rainfall is bimodal in distribution with the long rains falling between March and May, and the short rains from October to December. Temperature varies between 18 ^{o}C and 29 ^{o}C, with July being the coldest month while October and March are the warmest [17].

Experimental animals

The trial was conducted over an 8 week period from August to October, 2010 using 45 indigenous small East African goats. They were of mixed sexes with an average age and live weight of 7 month and 16.5 kg, respectively. The goats were randomly assigned into 3 groups of 15 animals based on fecal egg counts (FEC) with mean FEC being 430, 460 and 410 for groups I, II and III, respectively.

Treatments

Each goat of group I was treated orally with a capsule containing 2 g of COWP, equivalent to 1.7 g copper (Copinox®, Animax Ltd, UK). Each goat in group II received a COWP capsule and Curazole® [a 10% w/v oral suspension of Fenbendazole (FBZ); Univet Ltd, Ireland] at a dose rate of 5 mg kg^{-1} body weight. Group III goats were left untreated (control).

Parasitological methods

Rectal fecal samples were collected weekly from day 0 to 56 post-treatment. A modified McMaster technique was used to determine the eggs per gram of feces (epg) [17]. Group bulked feces were cultured and infective nematode larvae (L_3) recovered and identified to genus level [18, 19]. Three goats from each group were randomly selected on day 56 and humanely slaughtered for total and differential worm counts (WC). The worms were recovered using standard techniques [18, 19].

DATA ANALYSIS

Individual fecal egg count (FEC) and WC data of control and treated groups were log (x + 1) transformed to calculate geometric means (GM). The GM were used to calculate percent (%) reduction using the formula: ([C-T]/C) X 100, where C = GM count of the untreated control group and T = GM count for the COWP and COWP plus Curazole® (CUZ) treated groups [20]. For between group comparisons, the means of FEC and WC were compared for significance ($p<0.05$) by the non-parametric Mann-Whitney U test [21] using Instat software (Graph Pad Instat Inc. USA 1990-1994)

RESULTS AND DISCUSSIONS

Fecal worm egg counts

The weekly mean FEC for the 3 groups are shown in Fig.1. Most of the fecal samples from the naturally infested goats before treatment (day 0) had low to moderate numbers (mean = 433 epg) of strongyle eggs. The FEC for the control group ranged between 200–820 epg from day 0 to day 56. This subclinical nematodosis was probably associated with the climatic conditions of the study area rather than regular use of conventional anthelmintics [17, 22].

There was a significant ($p < 0.05$) drop of FEC for the two treatment groups from day 0 up to day 28 post-treatment, with FEC of COWP + CUZ group being significantly lower than that of the COWP group up to day 35 ($p < 0.05$) post-treatment. Percent FEC reduction from day 7 to 35 for COWP group was: days 7 (85.3%); 14 (93.4%), 21 (81%), 28 (58%) and 35 (30%) relative to COWP plus CUZ group which were: days 7 to 21 (100%), day 28 (87.8%) and day 35 (73.9%), respectively. From day 42 to 56, FEC were not significantly different between the 3 groups ($p > 0.05$) (Fig. 1). This indicated that there was selective removal of *H. contortus* by COWP (group I) while, COWP and Fenbendazole (FBZ) in Curazole® combination was able to clear all established strongylid worms in group II goats.

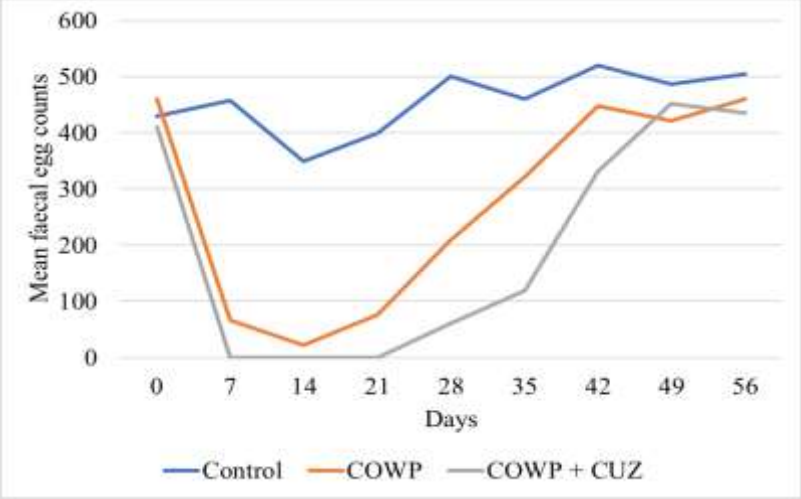

Fig-1: Mean fecal egg counts of control, COWP and COWP plus Curazole® treated groups during the study period

COWP = Copper oxide wire particles; COWP + CUZ = Copper oxide wire particles plus Curazole® (Fenbendazole)

Distribution of infective larvae from fecal cultures of control and treated groups

The percentage distribution of L_3 from fecal cultures of control and treated groups is shown in Fig. 2. The L_3 recovered from the control group were predominantly those of *Haemonchus spp.* (75.1%), *Trichostrongylus* spp. (21.8%) and *Oesophagostomum* spp. (3.1%). There was a significant ($p < 0.05$) drop of *Haemonchus spp.* L_3 relative to those of *Trichostrongylus* spp. for the COWP group up to day 14. This was followed by a gradual increase indicating that the goats could have been consuming L_3 during the study period or COWP was not effective against immature worms which continued to develop into adults in the gut [12]. *Trichostrongylus* spp. L_3 rose sharply and picked on day 14, and then declined gradually relative to *Haemonchus spp.* L_3 (Fig. 2). Earlier studies showed that COWP had limited effect on intestinal worms in small ruminants [11, 14, 15].

A marked drop of L_3 for the three nematode species was observed in the COWP + CUZ treated group ($p < 0.05$) up to day 21 post-treatment. *Trichostrongylus* spp. L_3 then increased sharply and dominated those of *Haemonchus spp.* up to day 42 when they started declining while, those of *Haemonchus spp.* increased gradually up to day 56 post-treatment. *Oesophagostomum* spp. L_3 remained consistently low for the two treatment groups throughout the study period (Fig. 2).

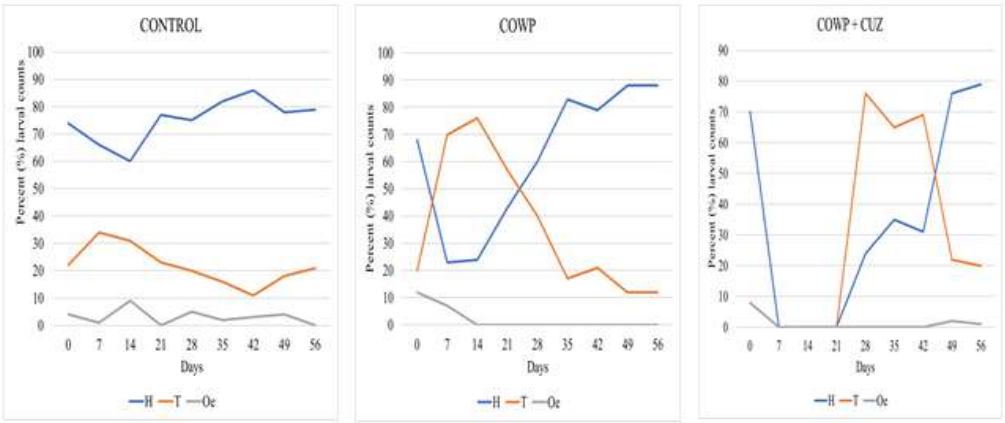

Fig-2: Percentage distribution of *Haemonchus* and *Trichostrongylus* species larvae in control, COWP and COWP plus Curazole® treated groups during the study period

H = *Haemonchus spp.*; T = *Trichostrongylus* spp.; Oe = *Oesophagostomum* spp

These findings were supported by percentage distribution of strongylid larvae (L_3) in group I (COWP) with *Trichostrongylus* spp. L_3 being more than those of *Haemonchus spp.* up to day 28 post treatment (Fig. 2).

A gradual increase in *Haemonchus spp.* L_3 was evident in group I after day 14 indicating that the goats could have been consuming L_3 during the study period or COWP was not effective against immature worms which continued to develop into adults in the gut [8]. These observations are supported by results of group II goats, where there was 100% FEC reduction for three consecutive samplings from day 7 to 21. This was followed by a gradual rise in FEC as the efficacy of COWP and FBZ decreased.

Worm counts of control and treated groups on trial termination

On study termination, worm counts (WC) of *H. contortus* for COWP and COWP + CUZ treatment groups were significantly ($p < 0.05$) lower than those of the control group. *Haemonchus contortus* WC between treatment groups were not statistically ($p > 0.05$) different (Table 1). These findings are supported by several studies in goats where the efficacy of COWP treatment was limited to about 4 weeks post-treatment, with no evidence of persistence of the anthelmintic effects beyond day 28 based on worm counts at necropsy [10, 14, 23]. As earlier reported by Waruiru *et al*. [22], *H. contortus* was the dominant nematode recovered followed by *T. colubriformis*, *O. venulosum* and *Trichuris ovis*, respectively (Table 1).

Table-1: Mean (range) and percent (%) reduction of worm counts in COWP, COWP plus Curazole and control groups

		DAY 56	
Parasite	Group	Mean worm count	[1]% Reduction
Haemonchus contortus	Control	[a]1650 (1091-2811	-
	[2]COWP	[b]680 (188-1202)	58.8
	[3]COWP + CUZ	[b]526 (40-1316)	68.1
Trichostrongylus colubriformis	Control	[a]320 (90-640)	-
	[2]COWP	[a]291 (176-377)	9.1
	[3]COWP + CUZ	[a]174 (30-262)	45.6
Oesophagostomum venulosum	Control	[a]18 (6-35)	-
	COWP	[a]15 (11-27)	16.7
	COWP + CUZ	[a]11(5-23)	38.9
Trichuris ovis	Control	2 (0-8)	-
	COWP	0 (0)	-
	COWP + CUZ	3 (1-7)	-

1% Reduction = ([C-T/C] × 100) where C is Control and T is Treated mean worm count; COWP = Copper oxide wire particles; COWP + CUZ= Copper oxide wire particles plus Curazole® (Fenbendazole); [a,] [b]Means in the same column with different superscripts are significantly different ($p<0.05$)

This study confirmed the usefulness of COWP as an anthelmintic to reduce pasture contamination and economic loses where *H. contortus* is the predominant GI nematode. In farms where conventional anthelmintics like benzimindazoles and imidothiazoles have failed due to AR resistance as reported by other workers [6, 7], use of COWP treatments is indicated.

CONCLUSIONS

The study revealed that COWP reduced *H. contortus* infestation up to day 28 post-treatment and may represent an alternative to conventional anthelmintics in the control of this parasite in goat farms. Further research should be conducted to determine the effects of repeated administration of COWP in heavily GI nematode infested goats and/or where AR is suspected.

ACKNOWLEDGEMENTS

This study was made possible by financial support from the Livestock Helminth Research Project within the Danish International Development Agency (DANIDA) ENRECA program. We thank Dr. H. Hoste (Toulouse, France) and Animax Ltd., UK for providing the COWP capsules.

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