Effect of three dosages of copper oxide wire particles on intestinal nematode infection and milk copper levels in lactating dairy goats tatiana L. Stanton[1], M.L. Thonney[1], D.D Bowman[2] and J.L. Liotta[2] **[1]Department of Animal Science, Cornell University, 507 Tower Rd, Ithaca, NY 14853, USA.**
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ABSTRACT

The effect of oral dosing with copper oxide wire particles (COWP) on gastrointestinal nematodes such as barber pole worm in lactating dairy goats has not been well documented. Additionally, some cheese makers have reported poor curd formation after COWP dosing. Sixteen, 15, and 15 lactating does in a commercial goat dairy were given HCOWP (1 g/10 kg live weight), MCOWP (2 g/head), or LCOWP (1 g/head), respectively. Does were fecal sampled, FAMACHA scored and their milk sampled for copper concentrations on day 0, 14, 28, and 42 after dosing. Each doe was blood sampled on day 42 to measure aspartate aminotransferase (AST), an indicator of copper toxicity. Barber pole worm eggs per gram (epg) decreased similarly for HCOWP and MCOWP from 0 to 14 days to approximately half of the original infection while barber pole worm eggs actually increased from day 0 to day 14 for LCOWP; P = 0.036 vs MCOWP and HCOWP). Curd formation for 4 cheese types remained consistent the week following COWP treatment. Average milk copper levels increased slightly between day 0 and day 14 but all values were within the pre-treatment range and COWP level had no effect. However, copper concentrations increased significantly (P = 0.003) from 0 to 14 days for HCOWP but not for MCOWP (P = 0.12) or LCOWP (P = 0.14). Plasma AST concentrations were within normal acceptable levels for all does on day 42. In this study, dosing dairy does with 2 g COWP/head rather that 1 g/10 kg live weight had the benefit of causing similar reductions in barber pole worm epg without causing the significant increase in milk copper concentrations from Day 0 to Day 14 noted at the larger dosage.

BACKGROUND AND OBJECTIVES

New York is blessed with an abundance of grazing land and plentiful rainfall. Our proximity to many metropolitan markets with diverse populations insures a large demand for goat dairy and meat products. Pasture-based goat dairying helps to reduce feeding costs and is a requirement for organic products. However, barber pole worm (*Haemonchus contortus*) is a major cause of death in Northeastern goat and sheep farms and many farmers report barber pole worm resistance to multiple dewormers. Copper oxide wire particles (COWP) are an alternative to chemical dewormers and have effectively reduced barber pole worm infection in goats and hair sheep in the Southeast U.S.

The negative effect of COWP on barber pole worms is not clearly understood. When the COWP become embedded in the wall of the true stomach (abomasum) , the acidity of the stomach caused by the stomach acids makes the copper soluble and it is slowly released. Barber pole worms unlike many other internal parasites reside in the true stomach and develop lesions when exposed to copper, possibly leading to death.

To our knowledge, there have been no reported studies on how well COWP controls barber pole worm in the Northeastern U.S. There are regional differences in the trace minerals that interact with copper such as molybdenum, sulfur, iron and zinc. Surveys also indicate that several Northeast goat farmers are

using COWP at higher dosages than recommended by Southeast researchers. In addition, some Southeast goat cheese processors have anecdotally complained of poor curd formation after dosing.

Objectives of this study were to determine:

- What dosages of COWP may be effective at controlling barber pole worm infection in milking dairy goats in the Northeastern U.S.
- How safe COWP is at these dosages for both the dairy does and the humans consuming their milk
- Whether cheese curd formation is impaired at these dosages

METHODS

Forty six milking dairy does at a commercial goat dairy in Northern NY were managed together but assigned to three different treatments. Sixteen, 15 and 15 does were given HCOWP (1 gram of COWP per 22 pounds of live weight), MCOWP (2 grams per doe), or LCOWP (1 gram per doe), respectively. COWP was given orally by bolus gun. Each doe was fecal sampled and FAMACHA scored immediately before treatment (day 0) and on day 14 (14 days after being dosed with COWP), 28 and 42. Milk samples to analyze for copper content were taken with milk meters from each doe on day 0, 14 and 42. Each doe was blood sampled on day 42 to determine aspartate amino-transferase (AST) enzyme concentration, an indicator of poor liver function and possible copper toxicity. Total strongyle worm eggs per gram for each fecal sample were determined with McMaster procedures. A lectin binding stain using a peanut agglutinin (PNA) was then used to determine what percentage of the Strongyle epg were barber pole worm eggs and calculate barber pole worm eggs per gram (BPW epg) for each fecal sample.

The goat farmer was unwilling to include a control group receiving no COWP for fear that control goats would need to be dewormed during the study and milk discarded. She also requested that we include a dosage (HCOWP) recommended on a popular online blog that contains more COWP than recommended by Southeast researchers.

RESULTS

Barber pole worm eggs per gram from day 0 to day 14 after COWP dosing decreased by 1185 eggs and 1191 eggs for treatments HCOWP and MCOWP respectively, and did not differ significantly between the two treatments ($P<0.993$, Table 1). In contrast, LCOWP behaved significantly differently ($P<0.036$). Rather than the barber pole worm eggs per gram (epg) decreasing 14 days after dosing, the BPW epg increased by 75 eggs for this treatment. Because there was no control group, we cannot estimate what the barber pole worm egg count would have been for does receiving no COWP versus getting the LCOWP treatment. The effect of COWP on this pastured herd appeared to be short lived. A mixed model REML analysis of the log transformed epgs between the 3 treatments over the four sampling days (0, 14, 28, 42) found no significant effect of either COWP treatment or COWP*day on either overall Strongyle epg or BPW epg during the 42 day study. The effect of day was significant ($P<0.013$) for Strongyle epg. Strongyle epg, BPW epg and FAMACHA scores tended to increase by day 42. The quickest and largest increases were seen in the LCOWP treatment.

Table 1. Change in fecal egg counts (epg) 14 days after COWP dosing

Treatments	Strongyle epg	Barber Pole Worm epg
HCOWP	-1153 ± 469.4	-1185 ± 462.7
MCOWP	-1227 ± 484.8	-1191 ± 477.9
LCOWP	107 ± 484.8	75 ± 477.9

The cheesemaker had been asked to observe whether the time to set curd and/or curd consistency was abnormal for the 4 types of cheeses made during the week following COWP dosing. She observed no changes.

Copper levels in milk increased slightly for most does from day 0 to day 14 but stayed within individual animal variations already exhibited on day 0 prior to dosing with COWP. Milk copper levels within each sampling day were not significantly different between each treatment nor were the changes in copper levels from day 0 to day 42 significant (Figure 1). However, in separate paired t tests, copper content increased significantly (ItI<0.003) from 0.105 ppm ± 0.019 to 0.171 ppm ±0.019 from day 0 to day 14 for HCOWP but not for MCOWP or LCOWP.

Copper toxicity elicits AST enzyme activity values of >300 ppm to 400 ppm. Plasma AST values on day 42 did not differ significantly between the treatments and were 117.9 ppm ± 6.9, 120.6 ppm ± 7.2 and 112.9 ppm ± 7.2 for HCOWP, MCOWP and LCOWP respectively (Table 2). Only two does had AST values greater than 200 ppm (203 and 221 ppm).

Figure 1. Effect of COWP treatment on copper levels in milk of dairy does

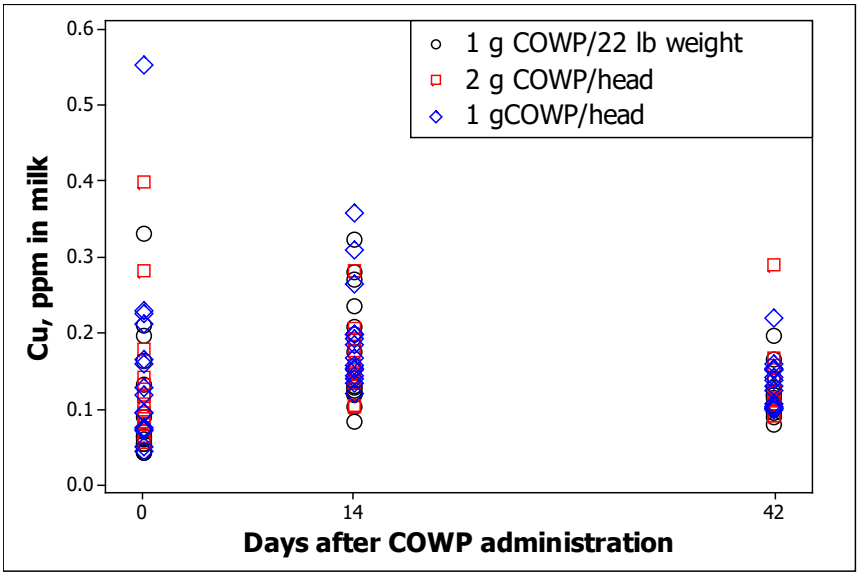

Table 2. **AST Enzyme Levels in Plasma 42 days after COWP Treatment**

Treatment	**AST level in parts per million (range is in parentheses)**
HCOWP	117.9 ppm (89 – 221)
MCOWP	120.6 ppm (76 – 203)
LCOWP	112.9 ppm (86 – 138)

CONCLUSIONS

In this study, oral dosing with COWP was not as effective as using a chemical dewormer, assuming no parasite resistance to the dewormer. However, COWP required no discarding of milk. Curd formation in four cheeses appeared normal. At the dosages studied, copper levels in milk were well below allowable levels and AST levels in blood did not indicate copper toxicity. The damaging effects of COWP on barber pole worm appear to be short lived. COWP dosing may need to be repeated over the grazing season in some goats. Determining the lowest effective dosage is very important to avoid possible copper toxicity.

In our study, dosing mature dairy does with 1 gram per doe did not decrease barber pole worm egg counts. However dosing with 2 grams per doe appeared to work as well as giving 1 gram per 22 pounds live weight with the advantage that it did not significantly increase copper levels in milk and only used 25% (large does) to 50% (small does) as much COWP. Further studies in NY have indicated that COWP results are very variable across herds. We recommend fecal sampling the herd before and after COWP use to determine if COWP is effective in your herd situation and using COWP as part of a well-planned IPM program

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