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Short communication

Control of gastrointestinal nematodes with copper oxide wire particles in a flock of lactating Polypay ewes and offspring in Iowa, USA☆

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Abstract

Copper oxide wire particles (COWP) have been used to reduce infection of *Haemonchus contortus* in hair breed lambs in southeastern USA without signs of copper toxicity. However, copper sensitivity among breeds and regions varies. The objective was to determine the effectiveness and safety of COWP in lactating Polypay ewes and their offspring grazing alfalfa/bluegrass pasture in a rotational grazing system. Mature Polypay ewes were administered 0, 0.5, 1, or 2 g ($n = 8$ or 9/dose) COWP approximately 60 days after lambing in mid-July 2005. Their offspring were administered 0 ($n = 6$), 0.5 or 0.75 g ($n = 9$), 1 or 2 g ($n = 6$) COWP 2 weeks later in late July. The primary gastrointestinal nematode was *H. contortus* (70%). Between Days 7 and 35, FEC were greater in 0 and 0.5 g COWP groups compared with ewes administered 2 g COWP (COWP × day, $P < 0.004$). PCV decreased in all groups of ewes between Days 0 and 21 (day, $P < 0.001$). Aspartate aminotransferase (AST) activity, a measure of liver copper levels, and body weight was similar among groups of ewes. FEC decreased within 7 days in COWP-treated compared with untreated lambs and remained low throughout experiment (COWP × day, $P < 0.05$). PCV increased in COWP-treated lambs between Days 7 and 35 and decreased in untreated lambs between Days 0 and 21 (COWP × day, $P < 0.009$). AST activity was similar among groups of lambs. Administration of 2 g COWP to ewes prevented a rise in FEC, but a dose of 0.5 g was ineffective as an anthelmintic. Administration of all doses of COWP to lambs decreased FEC and increased PCV compared to untreated lambs. There were no signs of copper toxicity in ewes or lambs. Alternative suppression of *H. contortus* infections may be necessary in ewes, but COWP was effective in *H. contortus* management for lambs.
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Keywords: Copper oxide; Ewes; *Haemonchus contortus*; Lambs; Parasites

1. Introduction

Widespread anthelmintic resistance of *Haemonchus contortus* has led to the necessity for alternatives to chemical control. Copper oxide wire particles (COWP) have been safely used in hair sheep for the control of gastrointestinal nematodes in which the primary species was *H. contortus* without risk of copper toxicity (Burke et al., 2004; Burke and Miller, 2006). COWP (2.5 or 5 g)

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have been used in Merino sheep in Australia, but were associated with an increased level of liver enzymes (GLDH; Knox, 2002), suggesting a level of toxicity. However, use and risk of copper toxicity of COWP as a dewormer in wool sheep in the U.S. has not been reported. The objective of this study was to determine effectiveness of COWP as a dewormer and examine risk of copper toxicity in lactating Polypay ewes and their lambs on grass and alfalfa pasture in Iowa.

2. Materials and methods

All experimental procedures were reviewed and accepted by the Iowa State University Animal Care and Use Committee in accordance with the NIH guide for the Care and Use of Laboratory Animals. Lactating Polypay ewes and their offspring grazed alfalfa/bluegrass pasture in a rotational grazing system as a single flock. Mature Polypay ewes were administered 0 ($n = 9$), 0.5 g ($n = 8$), 1 g ($n = 9$), or 2 g ($n = 8$) COWP approximately 60 days after lambing in mid-July 2005 (Day 0_{ewes}). Their offspring were administered 0 ($n = 6$), 0.5 or 0.75 g ($n = 9$; predator losses reduced number of lambs/dose in these groups, which were not significantly different for FEC and PCV and were pooled), 1 or 2 g ($n = 6$; these groups also were pooled) COWP at two months of age in late July (Day 0_{lambs}) when fecal egg counts (FEC; Whitlock, 1948) were determined to be increasing. FEC and packed cell volume (PCV) were determined between Days 0 and 35. Plasma was collected on Days 0, 14, and 28 for ewes and Days 7, 21, and 35 for lambs for determination of aspartate aminotransferase (AST) activity, a measure of liver copper levels (Buckley and Tait, 1981). Feces were pooled from a number of ewes within the flock and submitted for DrenchRite analyses (R.M. Kaplan, University of Georgia, USA).

Data were analyzed using the mixed models procedure of SAS (1996). The mathematical model used for PCV, FEC, AST, and body weight included treatment, day, treatment by day, and a repeated statement for day of measurement (Littell et al., 1996). Contrasts were determined using the PDIFF option (all probability values for the hypothesis) in SAS when probability was less than 0.05 percent. FEC data were log transformed: ln(FEC + 1). Statistical inferences were made on transformed data and untransformed least significant (LS) means were presented. There were no differences detected among COWP doses in lambs; therefore, data from COWP-treated lambs were pooled and compared with untreated lambs. If PCV declined below 19% animals were dewormed and removed from the data set thereafter. This occurred on Day 21 in three ewes that received 0 or 0.5 g COWP, one ewe each that received 1 or 2 g COWP (15–17% PCV), and one untreated lamb on Day 14 (16% PCV).

3. Results and discussion

A majority of gastrointestinal nematodes cultured were *H. contortus* (70%) and remaining population was *Trichostrongylus*. Cultured larvae were resistant to benzimidazoles and ivermectin. It is typical for small ruminants raised in the southeastern U.S. to possess drug-resistant worms (Miller and Barras, 1994; Kaplan et al., 2005), which indicates the importance of alternative parasite control measures such as COWP.

Seven days after administration of 1 or 2 g COWP to ewes, FEC were lower than those ewes treated with 0.5 g COWP or nothing (COWP × day, $P < 0.004$; Fig. 1A). Between Days 7 and 35 FEC were > 2000 eggs/g (EPG) for 0 and 0.5 g COWP-treated ewes and < 1000 EPG between Days 7 and 28 in 2 g COWP-treated ewes although this increased to 1550 EPG by Day 35. PCV decreased in all groups of ewes

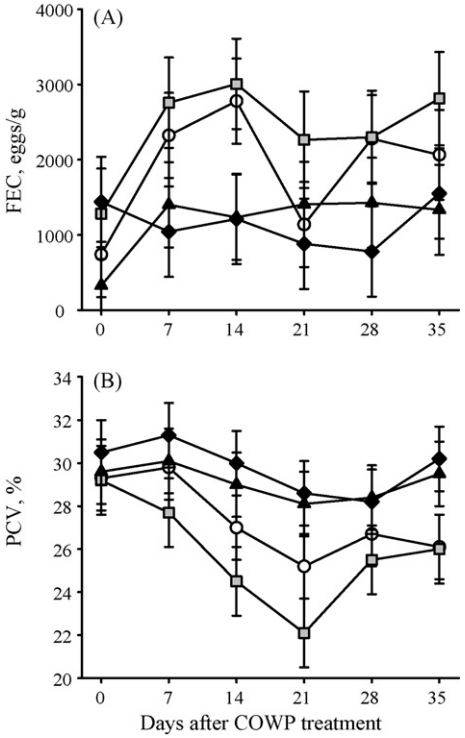

Fig. 1. Least squares means and standard errors of fecal egg counts (FEC; A) and packed cell volume (PCV; B) of ewes administered no ($n = 9$; open circles), 0.5 g ($n = 8$; shaded squares), 1 g ($n = 9$; closed triangles), or 2 g copper oxide wire particles (COWP; $n = 9$; closed diamonds) on Day 0.

between Days 0 and 21, though much less so in 1 and 2 g COWP-treated ewes (day, $P < 0.001$; COWP × day, $P < 0.14$; Fig. 1B). Deworming was necessary on Day 21 as indicated earlier based on PCV < 19%. COWP appear to be less effective in mature ewes compared with lambs (Burke et al., 2005), although reasons are unknown. In the present study, there was clearly a beneficial effect of 2 g COWP as indicated by reduced FEC and greater PCV. Larvae were not cultured from feces on Day 35, but increasing FEC at this time could indicate a shift in population from *H. contortus* to *Trichostrongylus*. *Trichostrongylus* appear to be less affected by COWP than *H. contortus* (Chartier et al., 2000; Terrill, unpublished data). This could explain an absence of anemia in most ewes treated with 1 and 2 g COWP, as *Trichostrongylus* is not a blood feeder.

FEC decreased within 7 days in COWP-treated compared with untreated lambs and remained low throughout the experiment (COWP × day, $P < 0.05$; Fig. 2A). PCV increased in COWP-treated lambs between Days 7 and 35 and decreased in untreated lambs between Days 0 and 21 (COWP × day, $P < 0.009$; Fig. 2B). Three untreated lambs were dewormed on Day 14 (only one with a PCV < 19%; two were mistakenly dewormed) and PCV increased thereafter for the untreated group; one 0.75 g COWP-treated lamb was dewormed on Day 7 (PCV = 14%). Previous observations have indicated that a reduction in FEC may be delayed by up to 14 days (Burke et al., 2004) and this lamb may have had a delayed response to COWP as FEC decreased by more than 90% between Days 0 and 7.

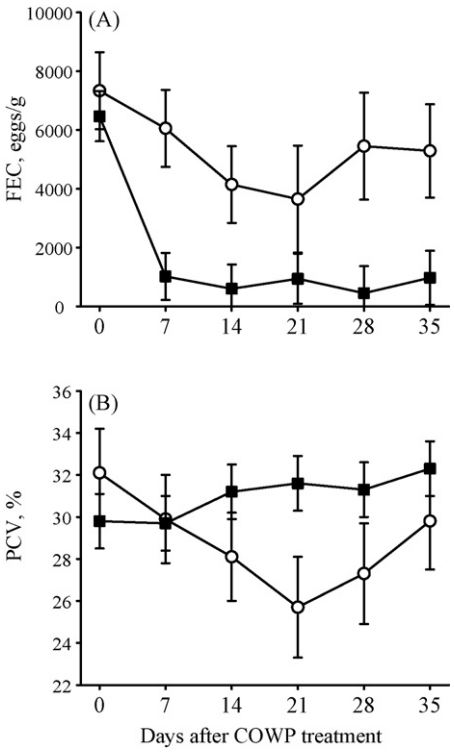

Fig. 2. Least squares means and standard errors of fecal egg counts (FEC; A) and packed cell volume (PCV; B) of lambs administered no ($n = 6$; open circles) or 0.5–2 g copper oxide wire particles (COWP; $n = 15$; closed squares) on Day 0.

AST activity was similar among groups of ewes (Day 0: no COWP, 158.3 ± 9.5; 0.5 g, 140.6 ± 10.1; 1 g, 165.4 ± 9.5; 2 g, 154.7 ± 10.6 U/L; Day 28: no COWP, 119.0 ± 10.5; 0.5 g, 125.7 ± 10.6; 1 g, 127.0 ± 10.5; 2 g, 137.7 ± 10.1 U/L; Day, $P < 0.001$). Body weight was also similar (Day 0: 67.4 ± 1.2 kg; Day 28: 68.8 ± 1.2 kg; Day, $P < 0.001$). AST activity in lambs was not different among groups (Day 7: no COWP, 75.2 ± 6.5; 0.5–2 g COWP, 80.8 ± 4.0 U/L; Day 35: no COWP, 77.1 ± 7.9; 0.5–2 g COWP, 89.0 ± 4.3 U/L; Day, $P < 0.001$). Body weight of lambs was similar (Day 0: 20.7 ± 1.3 kg; Day 21: 23.5 ± 1.5 kg; Day, $P < 0.001$). Body weight also was not different among hair breed lambs administered 0.5, 1 g COWP, or levamisole (Burke and Miller, 2006). Although copper toxicity could have developed beyond the 35-day observation period in the current study, earlier reports have indicated that while liver enzymes and concentrations of copper may be elevated in response to low doses of COWP, these measures of copper toxicity remained in the ''safe'' level (Burke and Miller, 2006). Nevertheless, caution should be exercised in use of COWP in sheep. The 0.5-g dose was as effective as higher doses in this study and in hair breed lambs (Burke and Miller, 2006) and should be used for control of *H. contortus* rather than higher doses. COWP should not be used when other forms of copper are being fed and professionals should be consulted for guidance on COWP use on farm.

In summary, administration of 2 g COWP to ewes prevented a rise in FEC, but lower doses were ineffective as an anthelmintic. Administration of all doses of COWP to lambs decreased FEC and increased PCV compared to untreated lambs. There were no signs of copper toxicity in ewes or lambs. Alternative management of ewes for *H. contortus* may be necessary, but COWP was effective in *H. contortus* control for lambs.

References

Buckley, W.T., Tait, R.M., 1981. Chronic copper toxicity in lambs: A survey of blood constituent responses. Can. J. Anim. Sci. 61, 613–624.

Burke, J.M., Miller, J.E., 2006. Evaluation of multiple low doses of copper oxide wire particles compared with levamisole for control of *Haemonchus contortus* in lambs. Vet. Parasitol. 139, 145–149.

Burke, J.M., Miller, J.E., Brauer, D.K., 2005. The effectiveness of copper oxide wire particles as an anthelmintic in pregnant ewes and safety to offspring. Vet. Parasitol. 131, 291–297.

Burke, J.M., Miller, J.E., Olcott, D.D., Olcott, B.M., Terrill, T.H., 2004. Effect of copper oxide wire particles dosage and feed supplement level on *Haemonchus contortus* infection in lambs. Vet. Parasitol. 123, 235–243.

Chartier, C., Etter, E., Heste, H., Pors, I., Koch, C., Dellac, B., 2000. Efficacy of copper oxide needles for the control of nematode parasites in dairy goats. Vet. Res. Commun. 24, 389–399.

Kaplan, R.M., Burke, J.M., Howell, S.B., Rocconi, J.R., 2005. Total anthelmintic failure on a meat goat farm in Arkansas, USA. In: American Association of Veterinary Parasitologists, 50th Annual Meeting, Minneapolis, MN.

Knox, M.R., 2002. Effectiveness of copper oxide wire particles for *Haemonchus contortus* control in sheep. Aust. Vet. J. 80, 224–227.

Littell, R.C., Milliken, G.A., Stroup, W.W., Wolfinger, R.D., 1996. SAS System for Mixed Models. SAS Institute Inc., Cary, NC, 656 pp.

Miller, J.E., Barras, S.R., 1994. Ivermectin resistant *Haemonchus contortus* in Louisiana lambs. Vet. Parasitol. 55, 343–346.

SAS/STAT® Software: Changes and Enhancements through Release 6.11, 1996. SAS Inst Inc., Cary, NC.

Whitlock, H.V., 1948. Some modifications of the McMaster helminth egg-counting technique apparatus. J. Coun. Sci. Ind. Res. 21, 177–180.