Copper Oxide Wire Particles to Control *Haemonchus contortus* in Sheep and Goats

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Introduction

The American Consortium for Small Ruminant Parasite Control (ACSRPC) began to examine the use and safety of copper oxide wire particles (COWP) as an anthelmintic for sheep and goats in 2003 due to the universal prevalence of anthelmintic resistance. COWP are available commercially to alleviate copper deficiency in ruminant livestock. COWP can be included in an integrated gastrointestinal nematode (GIN) control program, specifically to control *Haemonchus contortus* (Burke et al., 2004, 2007b; Burke and Miller, 2006a; Spickett et al., 2012). Because sheep are susceptible to copper toxicity, caution must be employed if COWP is used as an anthelmintic.

Efficacy against GIN

Bang et al. (1990a) reported a 96% reduction in adult *H. contortus* and 56% reduction in *Teladorsagia circumcincta* (another abomasal nematode) in lambs administered COWP. However, Chartier et al. (2000) reported a 75% reduction in *H. contortus* and little effect against *T. circumcinta* or *Trichostrongylus colubriformis* (intestinal nematode) in goats administered COWP. Knox (2002) observed an anthelmintic effect of COWP against developing larvae, but other studies showed limited or no effect (Waller et al., 2004; Burke et al., 2007b; Vatta et al., 2009). Soli et al. (2010) determined that efficacy of COWP to reduce *H. contortus* was similar between lambs and kids. Doses of COWP as low as 0.5 g administered to lambs (Burke and Miller, 2006a) or kids (Burke et al., 2007b), and 1 g to mature ewes (Burke et al., 2007a) was effective in reducing an infection of *H. contortus*.

Mode of Action

COWP administered as a bolus or in the feed (Burke et al., 2010a, b) quickly moves through the rumen and much is retained in the folds of the abomasum, where *H. contortus* develops to its adult stage. The bioavailability of copper in the gastrointestinal tract is sensitive to pH. Bang et al. (1990b) determined that copper from COWP in the abomasum was insoluble at pH greater than 3.4, which often occurs in GIN infects lambs (pH of uninfected lambs was less than 1). It was thought that COWP could be indirectly acting on adult nematodes throught the increased copper status of the host, or directly due to increased copper in the abomasum, which could potentially penetrate the cuticle of *H. contortus*. Moscona et al. (2008) found evidence of a direct effect of COWP on *H. contortus*. The Louisiana State University group determined through transmission electron microscopy that cuticle lesions occurred on *H. contortus* from COWP treated lambs, with the greatest frequency of lesions observed within 12 hours post-treatment, but still present 84 hours later. Concentrations of copper were also higher in *H. contortus* from COWP treated than untreated lambs. Even though particles can be found in the abomasum for several weeks (Judson et al., 1984; Burke et al., 2004), anthelmintic activity does not persist more than 21 days (Burke et al., 2007b) or 41 days (Vatta et al., 2012).

Forms of Copper

Copper sulphate was used as an anthelmintic before synthetic anthelmintics were developed (Wright and Bozicevich, 1931). However, we found no value in including copper sulphate in the mineral or feed of growing goats for control of *H. contortus* (Burke and Miller, 2008). We reported a reduction in fecal egg counts in goats treated with a sustained-release multi-trace element/vitamin ruminal bolus that contained 3.7 g copper as copper oxide (Burke and Miller, 2006b). An industrial form of COWP was examined for the control of *H. contortus*, but failed to reduce fecal egg counts (Burke and Miller, unpublished data). The COWP available for the treatment of copper deficiency in cattle (Copasure; Animax Ltd., Suffolk, England) was used in nearly all of the ACSRPC research. Recently, the same company offered a similar product for lambs and kids in 2 g and sheep and goats in 4 g, which would be a dose used to treat copper deficiency, but too high for repeated anthelmintic use. Other commercially available forms of COWP recently commercialized in the U.S. have not been examined for the control of *H. contortus* in sheep and goats, but experiments are pending. It is important to conduct trials with a known *H. contortus* infection; otherwise, results can be misleading (Burke et al., 2010a).

Other Research

Burke et al. (2005b) noted that COWP did not adversely affect the ability of *Duddingtonia flagrans*, a nematode trapping fungus, to reduce larval development. There were no adverse effects of administering COWP (2 g) to pregnant Katahdin ewes or their offspring (Burke et al., 2005a). The safety of using COWP in lactating Polypay ewes and their offspring occurred in collaboration with Iowa State University; no signs of copper toxicity or reduction in lamb production were observed (Burke et al., 2007a). There was evidence that a combination strategy using both COWP and sericea lespedeza was more effective than either strategy along (Burke et al., 2012). Currently an experiment is being conducted to examine long term effects of COWP administered every 4 to 6 weeks to sheep during their productive stage (before and during lactation in ewes; post-weaning to lambs) conducted during a three year period (Burke, Miller, Terrill, Mosjidis). Lamb production appears to be similar between the COWP and a control group using synthetic anthelmintics.

Summary

While the risk of copper toxicity should always be evaluated before a decision to use COWP as an anthelmintic, especially for sheep, low doses of COWP are an effective means to control *H. contortus* in the face of anthelmintic resistance. At present, COWP is allowed as an anthelmintic by organic certifiers in the U.S., giving an alternative to organic producers and those wishing to minimize chemical use in small ruminants. Producers should always consult a veterinarian, livestock specialist, or professional in formulating a GIN control strategy best suited to their production system.

[1]Mention of trade names or commercial products in this manuscript is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

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