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Drug Resistant Worms:

Anthelmintic Resistance is a Growing Concern for Alpaca Owners

BY DR. LISA WILLIAMSON

Scientists from the University of Georgia College of Veterinary Medicine evaluated 32 privately owned camelid (16 alpaca and 16 llama) farms in the southeastern United States to determine if anthelmintic (dewormer) resistance was evident in the *Haemonchus contortus* (barberpole worm) populations on these farms. The Research was funded through the Alpaca Research Foundation and the Morris Animal Foundation. The researchers are grateful to these funding agencies, and in particular, to the wonderful alpaca and llama producers who allowed us to come to their farms and use their animals for the study.

Problems with drug-resistant *Haemonchus contortus* worms have been well documented on small ruminant

farms, but prior to this study, it was unclear to what extent this problem existed in camelid herds. *Haemonchus contortus* is a virulent blood-feeding nematode capable of causing weight loss, weakness, anemia, hypoproteinemia (low blood proteins), dependent edema, diarrhea, and in extreme cases, death, in heavily parasitized, vulnerable animals.

The camelid study revealed that *Haemonchus contortus* was the primary nematode parasite on all the farms studied, followed in prevalence by *Trichostrongylus colubriformis*, and *Nematodirus* spp. Larval developmental assays were performed on the *Haemonchus contortus* isolated from these 32 camelid farms to determine sensitivity or resistance to commonly used dewormers.

The larval developmental assay (LDA) is performed in a laboratory by isolating worm eggs from fecal samples, and by then hatching out the larvae within special test wells, to which varying concentrations of a dewormer have been added. The LDA specifically tests the efficacy of the 3 main classes of dewormers represented by levamisole, ivermectin, and thiabendazole. Resistance or sensitivity to moxidectin is deduced based on the ivermectin dose response.

The results clearly showed that dewormer resistance was present to some degree on all the camelid farms tested. In fact, all 32 (100 percent) of the farms had benzimidazole resistant *Haemonchus contortus*. Examples of benzimidazole drugs are fenbendazole (Panacur®, Safe-Guard®), and albendazole (Valbazen®). Ivermectin resistance was evident on 97 percent of the farms. Levamisole and moxidectin tested much more favorably; only 22 percent of the farms' resident *Haemonchus contortus* isolates were resistant to these two dewormers.

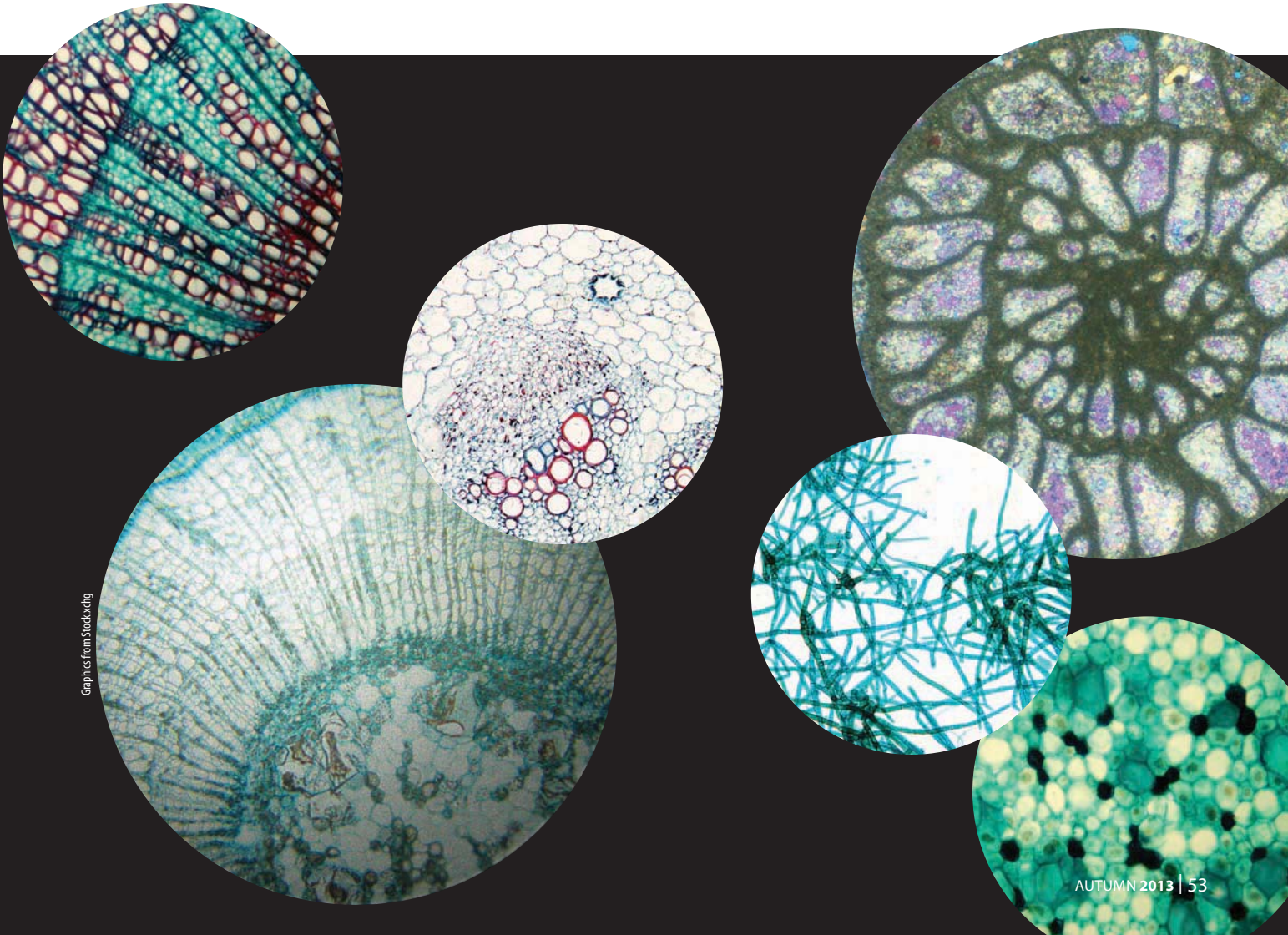
Of interest was the finding that 97 percent of the farms had resistance to more than one dewormer! Even more sobering was the finding that four farms

had *Haemonchus contortus* that was resistant to ivermectin, levamisole and benzimidazoles. Moxidectin was the only dewormer that tested as still fully effective on those 4 farms.

That finding is worrisome because moxidectin resistance can evolve within a couple of years of unselective use if ivermectin resistance is already present. Ivermectin and moxidectin share the same chemical class, as they kill worms in the same manner; moxidectin is simply a much more potent drug than ivermectin.

The most alarming observation was that one farm was identified with *Haemonchus contortus* that were resistant to ALL the dewormers tested. This finding is called "total anthelmintic failure." In this sort of situation, nonchemical worm control becomes the only alternative left to the producer once a high level of resistance is present in all available dewormers. Ideally, we want to keep dewormers effective for as long as possible by using them only when necessary to maintain animal health, and by minimizing treatment of animals that are not showing any symptoms of disease.

When *Haemonchus contortus* is the main worm causing havoc on the farm, two important indicators of



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Anthelmintic resistance can arise through frequent whole-herd treatment. Ideally, we want to keep dewormers effective for as long as possible by using them only when necessary, and by minimizing treatment of animals that are not showing any symptoms.

which llamas and alpacas are most likely to need treatment with an effective dewormer are (1) decreased body condition and/or unexplained decrease in body weight, and (2) the FAMACHA® score. Decrease in body condition or weight to suboptimal levels is actually a good indicator of parasitism from any pathologic nematode or coccidian, as well as of other disease states.

FAMACHA testing mainly identifies signs of anemia, so pale scores are often associated with heavy *Haemonchus contortus* burdens. Other problems can produce anemia, so it is not a specific finding. However, haemonchosis is by far the most common cause of anemia on farms where *Haemonchus contortus* is present.

The Research Team from the University of Georgia College of Veterinary Medicine validated the FAMACHA System for use in alpacas and llamas. The study concluded that the FAMACHA System is a useful tool in llama and alpaca herds where *Haemon-*

chus contortus is an issue. The FAMACHA System was developed to enable small ruminant producers to compare their animals' lower conjunctival color with the color blocks on a standardized laminated FAMACHA card, so that treatment decisions could be made on the spot. Francois Malan, a South African veterinarian, is credited with observing the association between hematocrit and eyelid pallor in parasitized sheep in South Africa over 30 years ago. He and his colleagues developed the FAMACHA chart, which depicts five illustrations of ocular membrane colors: 1: deep red (nonanemic), 2: red-pink (nonanemic), 3: pink (mild anemia), 4: white-pink (anemic), and 5: white (severely anemic).

Camelids with bright red-to-red/pink conjunctival color (FAMACHA categories 1 and 2) have lower egg counts, higher hematocrits and better body condition scores than camelids with pale conjunctival color.

Camelids scoring in these nonanemic categories do not need dewormer treatment.

Camelids scoring in FAMACHA categories 4 and 5 (pale) are much more likely to be clinically anemic and had significantly higher fecal egg counts. Animals scoring in these categories need a dewormer treatment. Camelids scoring in FAMACHA category 3 are usually not anemic. They can be treated or left untreated, depending on various circumstances. For instance, they can be left untreated if they are in optimal body condition, and not under stress (other diseases, pregnancy, lactation), and if worm transmission is minimal.

The American Consortium for Small Ruminant Parasite Control website is a good place to check for where and when FAMACHA training is available in your area. Go to www.scrpc.org to view informative resources from this Organization, which recently celebrated its 10th anniversary with an international conference. The proceedings of the American Consortium for Small Ruminant Parasite Control Tenth Anniversary Conference are available on the website.

Anthelmintic resistance can arise on a farm through introduction of new animals harboring resistant worms, and by creating them through frequent whole-herd treatment. It is important to quarantine new arrivals off the pastures until a fecal egg count is performed. If the animal is shedding nematode eggs, it should be treated with dewormers and not allowed on the pasture until a repeat fecal test 10-14 days after treatment demonstrates it is no longer shedding nematode eggs.

The most predictable way to create dewormer resistance on a farm is to treat the whole herd with a dewormer, particularly if the herd is then moved to a "safe" (little-to-no larvae) pasture. The nematode parasites that survive treatment are highly drug-resistant. With no competition from nematodes still sensitive to the drugs, the resistant nematodes breed with each other and re-populate the animals with their highly resistant offspring.

Dosing dewormers at sub-therapeutic levels can contribute to development of resistance in worm populations. This issue is particularly of concern in camelids, as most dose regimens have been extrapolated from other species rather than through specific testing. A recent study in llamas and alpacas indicated that oral moxidectin (Cydectin® Oral Drench for Sheep) provided the most consistent, effective response against *Haemonchus contortus* isolates shown to be sensitive to this dewormer, when it was dosed orally at 0.4 mg/kg. This dose is 2X the dose recommended for sheep and cattle, but it is the same dose recommended for goats. Interestingly, when inject-

able moxidectin (Cydectin® Injectable for Cattle) was dosed up to 0.4 mg/kg subcutaneously in llamas and alpacas with moxidectin-sensitive *Haemonchus contortus* burdens, treatment failed to achieve satisfactory reductions in the fecal egg count tests. These results re-enforced the current recommendation to use oral dewormers when treating worms that dwell within the digestive system. Studies in small ruminants have demonstrated that higher concentrations of dewormers are achieved within the worms when they contact the drug in the digestive tract, which translates into better efficacy.

Testing for dewormer resistance is a good idea, particularly if dewormer treatment is not achieving the expected benefit. The larval developmental assay is available through Dr. Ray Kaplan's laboratory. For details, contact Sue Howell atjscb@uga.edu. Alternatively, a fecal egg count reduction (FECR) test can be performed on the farm. Although there are several ways to conduct the test, comparison of the pre-treatment (pre tx) fecal egg count with the 14-day post-treatment (post tx) fecal egg count (FEC) is well suited for small numbers of animals. To ensure the most meaningful results, animals should be weighed and dosed appropriately with the dewormer being tested. Fecal egg counts should be performed using either a McMaster's technique or a centrifugation technique.

The formula for the FECRT is given below:

$$\% \text{ FECR} = \frac{\text{pre tx mean FEC} - \text{post tx mean FEC}}{\text{pre tx mean FEC}} \times 100$$

An efficacious treatment will result in an FECR of 95-100 percent. Clinical benefit is still perceived when resistance level is low (< 90 percent), but once efficacy slips to 50 percent or lower, treatment failure is obvious. Since anthelmintic resistance evolves dynamically, resistance testing should be repeated every two to three years.

Dr. Lisa Williamson is an Associate Professor in the Department of Large Animal Medicine at the University of Georgia College of Veterinary Medicine. She received her bachelor's degree in 1978, her DVM in 1981, and her Masters degree in Physiology in 1990, from the University of Georgia. She became a diplomate of the American College of Veterinary Internal Medicine in 1991. Dr. Williamson worked in large animal private practice in Virginia and New York, and as a clinical instructor at the University of Wisconsin before joining the faculty at the University of Georgia College of Veterinary Medicine in 1989. Dr. Williamson is currently a field service clinician who works with all large animal species. Her research efforts have been directed at characterizing anthelmintic resistance in sheep and goats, and most recently, camelids. Dr. Williamson joined the American Association for Small Ruminant Parasite Control shortly after its inception in 2002. She has organized and conducted many FAMACHA workshops in Georgia since 2006, and is the vice president of the Alpaca Research Foundation.