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Best Management Practices for Internal Parasite Control in Small Ruminants

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BEST MANAGEMENT PRACTICES FOR INTERNAL PARASITE CONTROL IN SMALL RUMINANTS

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Abstract

Internal parasites represent a significant obstacle to a profitable and sustainable US goat industry. In some states, internal parasites are a year-round problem, while in others, they are a more seasonal challenge. Traditionally, parasite control methods relied heavily on antiparasitic drugs called anthelmintics or dewormers. Continued use and misuse of these drugs have resulted in increasingly resistant worm populations, necessitating more holistic or integrated methods of parasite control. A combination of practices will usually be necessary to achieve a satisfactory level of control. This paper discusses best management practices for controlling internal parasites in small ruminants, including pasture and grazing management, nutrition, zero grazing, and genetic selection, targeted selective treatment (TST), bioactive forages (e.g., sericea lespedeza) and copper oxide wire particles. Because the judicious use of anthelmintics is essential to effective parasite control, the paper additionally discusses the proper use of antiparasitic drugs, including how to measure and manage drug resistance.

Keywords: Best Management Practices, Internal Parasites, Parasite Control, Small Ruminants

Introduction

According to USDA statistics, internal parasites accounted for the highest percentage of non-predatory losses of goats in 2015, resulting in 87,000 goat and kid deaths (USDA, 2017). All stakeholders in the Needs Assessment Survey for the upcoming National Animal Health Monitoring System (NAHMS) 2019 Goat Study ranked internal parasites as the most important disease concern (USDA, 2018). In some states, internal parasites are a year-round problem. In other states, they are a more seasonal challenge. Traditionally, parasite control methods relied heavily on antiparasitic drugs called anthelmintics or dewormers. Long-time use and sometimes misuse of these drugs has resulted in worm populations that are increasingly resistant to this approach, necessitating more holistic or integrated methods of parasite control.

Best Management Practices

Biology

In order to control internal parasites in a goat herd, it is first necessary to understand the biology of the parasites and the host animals. Goats can be infected with a wide range of internal and external parasites. It is normal for goats to have some level of parasitic infection. *Haemonchus contortus* (barber pole worm) is the most pathogenic worm species and tends to be the most numerous parasite in warm, moist climates or during periods of warm, moist weather (in cooler climates). Other important parasites include *Teladorsagia* (*Ostertagia*; brown stomach worm) and *Trichostrongylus* (black scour worm).

The barber pole worm is found in the abomasum, where it feeds on blood, causing blood and protein loss. Anemia and "bottle jaw" (submandibular edema; accumulation of fluid under the jaw) are the most common signs of clinical infection. *Teladorsagia* and *Trichostrongylus* feed on

intestinal tissue or fluids, causing digestive disturbances; diarrhea (scours) is common and production losses (e.g. reduced weight gain) is the primary concern.

Worm eggs are shed in the manure of infected goats. The cells inside the egg form larvae that hatch out of the egg. After hatching, the larvae feed on bacteria and go through two molts, before becoming infective third-stage larvae (L3). The L3 make their way out of the manure onto the forage, where they are ingested by grazing goats. The length of time that the L3 can survive on pasture varies and is affected by environmental conditions. The life cycle of the barber pole worm is 17 to 21 days. The female is a prolific egg layer.

When environmental conditions are not conducive to their development, Ingested larvae develop into a "hypobiotic" or arrested stage, where they do not continue their development, but "hibernate" in the stomach or small intestine until environmental conditions improve. In fact, hypobiosis is the primary means by which parasites survive the winter months. Hot, dry weather can also cause parasites to undergo hypobiosis. In warm, wet climates, hypobiosis is less important, as year-round weather conditions may permit the parasites to complete their life cycles.

Copper Oxide Wire Particles

Copper oxide wire particles (COWP) are tiny rods of copper oxide. They are a slow-release form of copper versus copper sulfate, which is rapidly absorbed and potentially toxic, especially to sheep. While results can be variable, there is scientific evidence that COWP reduce barber pole worm infections in goats.

Recommended dosages are based on age, not weight. Doses that have proven effective are 0.5 to 1 g for kids and 1 to 2 g for mature goats. It is recommended that cattle boluses be re-packaged into smaller doses for goats. Some of the COWP boluses that are sold for goats contain more copper than is necessary for anthelmintic treatment, as these products are formulated to provide supplemental copper to goats whose diets are deficient in copper.

Similar results can be expected from different commercial sources of COWP (Burke et al, 2016). Administering COWP can be tricky. COWP can be administered with an appropriate size balling gun or a small PVC pipe with a wooden dowel. A little peanut butter will keep the bolus from falling out of the balling gun.

A recent study (with lambs) showed that when COWP were combined with albendazole (Valbazen®), treatment efficacy was more effective than either treatment alone (Burke et al, 2016). Unpublished data suggest a similar advantage when COWP are combined with levamisole (Burke et al, 2016).

Genetics

Genetics may offer the best long-term solution to internal parasite control in small ruminants. Resistance is the ability of the animal to limit infection. Fecal egg count (FEC, reported as eggs per gram or EPG) is the primary measure of parasite resistance. Resilience is the ability of the animal to "tolerate" infection. Resilient animals will have lower (better) FAMACHA© scores and other indicators of superior health and performance. Resistance and resilience are both heritable traits and should respond favorably to selection.

Resistant animals will shed fewer eggs and have consistently lower fecal egg counts than their more susceptible herd mates. In the scientific literature, heritability estimates for fecal egg count in goats range from 0.2 to 0.33. A Lincoln University study estimated the heritability of FEC in goats to be 0.11 ± 0.07 (Thomas et al, 2016).

More resistant bucks and does should produce more kids that are more resistant to parasites. Since the male influences most of the genetics in the herd, it is imperative that he demonstrate resistance to internal parasites. The most susceptible does in the herd should probably be culled and their offspring should not be saved for replacement.

To identify resistant goats in a herd, the fecal egg counts of similar animals should be compared. It is important that the parasite challenge be sufficient. A group average of at least 500 epg is recommended; 1000 eggs per gram (epg) is better. Allowances should be made for does raising multiples versus does raising singles or kids raised as multiples vs. singletons.

In the scientific literature, there are no estimates for the heritability of FAMACHA© scores in goats. The Lincoln University study estimated the heritability of FAMACHA© scores in goats to be 0.11 ± 0.08 (Thomas et al. 2016). FAMACHA© scores and other performance indicators can be used to select resilient animals. FAMACHA© scores and fecal egg counts tend to be correlated, so selection for more resilient animals should result in more resistant animals as well.

An alternative to selection is to raise more resistant/resilient breeds of goats. Breed comparison studies conducted at Tennessee State University showed that Spanish and Kiko goats were more worm resistant than Boer goats (Wang et al, 2017). Myotonic goats had the lowest fecal egg counts among the breed types compared (Wang et al, 2017). Crossbreeding may also aid in parasite control.

Management

Effective parasite control starts with good management, hygiene, and biosecurity. Overstocking and overgrazing are primary causes of clinical parasitism and outbreaks of coccidiosis. Feeders and water receptacles need to be kept free from fecal matter. Pens need to be kept dry. “Hot spots” on pastures need to be avoided. Hot spots are places where the risk of parasite infection is greater, such as wet areas and areas where animals congregate.

In some climates, kidding in the winter or fall can reduce parasitism, as environmental conditions may be less conducive to the development of parasites. Weaning age can impact parasite risk. Early-weaned kids are more susceptible to parasitic infections than those that remain with their dams for longer periods. If kids will be grazed, it is recommended that they not be weaned before 90 days. A recent study with lambs showed that delaying weaning until 120 days had a beneficial effect on parasite status (Campbell et al, 2017).

Zero grazing is a popular strategy for controlling worms, especially in lambs. In a zero grazing situation, there is no vegetation for grazing; thus, no opportunity for infection or re-infection. Animals can be kept in barns or in dry lots. The feed is brought to them and fed in feeders. Zero grazing is an especially good strategy for at-risk animals, such as growing kids and periparturient females. Coccidia can still be a risk since it is transmitted in feces.

It is important not to introduce resistant worms to a farm. Newly acquired animals should be put in quarantine and administered dewormers from each dewormer class. Ideally, they should not be released from quarantine until their fecal egg counts are zero.

Managing Dewormer Resistance

Numerous studies have documented widespread resistance to all dewormers and dewormer classes (Crook et al, 2016; Schoenian et al, 2017). On average, resistance is highest in the benzimidazoles and avermectins and lower in moxidectin and levamisole. Some farms, especially those in the South, have resistance to all dewormers and dewormer classes. Resistance varies by geographic area and individual farm. Farms and geographic areas that have dewormed more frequently will likely have greater levels of resistance. Resistance is/was inevitable. All that producers can do is control the rate by which resistance develops.

Most producers start to suspect drug resistance when clinical signs persist and/or fecal egg counts remain high following a properly administered drug treatment. There are two ways to determine drug resistance: the fecal egg count reduction test (FECRT) and the DrenchRite® larval development assay (LDA).

With the FECRT, drug effectiveness is determined by comparing before and after (7-14 d) fecal egg counts or by comparing fecal egg counts from treated and untreated (control animals). The FECRT can be done with individual and pooled fecal samples, but the same animals must be sampled each time. Ten to 15 samples are needed for each drug. A minimum fecal egg count of 250 epg is needed. Much higher egg counts are preferred and will greatly improve accuracy. Fecal egg counts can be performed by veterinarians and diagnostic labs. Producers can learn to do fecal egg counts.

The DrenchRite® test determines resistance to all dewormer groups simultaneously from a single pooled fecal sample. Fecal samples from approximately 10 animals are needed. A minimum fecal egg count of 500 epg is required. In addition to determining resistance, the DrenchRite® test does a larvae ID, letting producers know which parasites are infecting their animals. Ray Kaplan's lab at the University of Georgia is the only place in North America that does the DrenchRite® test.

For both tests, if fecal egg count is reduced by less than 95 percent, drug resistance is present and steps need to be taken to manage resistance.

Nutrition

Nutrition is a very important aspect of internal parasite control. Supplemental protein, especially by-pass protein, has been well-documented to both reduce the negative effects of parasitism as well as bolster the immune system to prevent parasite infection. Incorporating legumes into pastures is one way to provide additional protein. Goats can also be supplemented with a source of by-pass protein, such as cottonseed meal. Young animals have higher protein requirements and are more subject to protein undernutrition. Since nutrition requirements do not factor in the effects of parasitism, it is often necessary to feed protein in excess of nutrient requirements in order to meet requirements and/or derive additional benefit.

In addition to protein and energy, minerals and vitamins are also important to immune system function. It is generally recommended that grazing animals be supplemented with minerals and vitamins. A loose formulation is preferred to a block. Prices and quality of minerals vary. Consider mineral content and recommended consumption when deciding which product to buy. Mineral supplements should contain sufficient levels of minerals which are deficient in your area.

Goats in better body condition are better able withstand the effects of parasitism. Body condition score is part of the Five Point Check© and should be used as a deworming criteria. Goats should be handled regularly to determine body condition score. Those below 2 (scale 1 to 5) will be at greater risk for parasitism and should be managed appropriately.

Parasite and Grazing Management

Since goats get infected with infective worm larvae when they graze, pasture and grazing management will obviously have a large effect on the level of infection. When implemented correctly, rotational grazing can decrease exposure to infective worm larvae. If goats are forced to continuously graze, they may re-graze the same areas, potentially re-infecting themselves with parasites. Rotational grazing allows producers to control how short plants are grazed, the length of time animals graze a paddock and the length of time between grazing events. The majority of infective worm larvae are found in the first 3 inches of vegetation. For this reason, pastures should not be grazed shorter than 3-4 inches. Because it takes 4-5 days for worm eggs to develop into infective third-stage larvae (L3), it is recommended that animals be moved frequently, e.g. every few days.

The use of annual forages can reduce the risk of parasite infection, as not only do they offer clean grazing (initially), but grazing height is usually higher. Allowing goats to browse on woody plant species encourages higher grazing and less chance of picking up infective worm larvae. Browsing is the natural means by which goats avoid getting infected with parasites. They are not intended to graze, like sheep and cattle. This is why their development of immunity is inferior to other species.

Multi-species grazing can be another effective grazing strategy, as cattle and horses generally do not share the same parasites as goats (and sheep). Mixed species grazing can also lead to better pasture utilization and may lead to improved predator protection.

Proper Use of Dewormers

Anthelmintics (dewormers) are a valuable, but limited resource. They must be used properly to ensure their continued effectiveness. There are three classes of dewormers commonly used to treat goats (Table 1). Dewormers are separated into classes based on their chemistries and common modes of action. Dewormers in the same class can exhibit cross-resistance.

Proper use of dewormers starts with giving the proper dose of medicine, as under-dosing is one of the primary causes of drug resistance. Dosage should be based on actual (accurate) weights. If scales are not available, weigh tapes and weigh calculators can be used for dairy and meat goats, respectively. Because goats metabolize drugs more quickly, it is recommended that they are given 1.5-2x the sheep dose. Most of the drugs have wide margins of safety. Levamisole has the

Table 1. Classes of Dewormers

Drug Class	Drug Ingredients	Tradenames
Benzimidazoles	Fenbendazole* Albendazole* Oxydendazole	SafeGuard® Valbazen® Synanthic®
Macrocylic lactones	Ivermectin Eprinomectin Doramectin Moxidectin	Ivomec® Eprinex® Dectomax® Cydectin®, Quest®
Nicotinic agonists	Levamisole Morantel* Pyrantel	Prohibit®, Leva-Med® Rumatel®, Positive Pellet Strongid®

*FDA-approved for goats

narrowest margin of safety (3x dose); so care should be taken not to overdose it. It should be given to goats at 1.5x the sheep dose.

All dewormers should be administered orally using an oral dosing syringe. Drugs should be delivered over the tongue, deep into the oral cavity. Depositing a drug into the mouth may cause the drug to bypass the rumen, which will reduce effectiveness. Withholding feed for 12-24 hours may increase the efficacy of treatment with the benzimidazoles and/or ivermectin; however, feed should not be withheld from certain classes of animals, e.g. does in late gestation. Repeat (multi-day) dosing is another strategy that may increase efficacy. Long-acting preparations should not be used, as their use accelerates drug resistance.

It is no longer recommended that dewormers be rotated after use. Combination treatments are now recommended as a means to prolong dewormer effectiveness. A combination treatment is when multiple dewormers are administered at the same time. Combination dewormers are available in other countries, but none are available in the US. To administer a combination treatment, each dewormer should be administered sequentially (at full dose) in a separate dosing syringe. The most potent drug from each drug class is given. The recommended combination treatment is Albendazole (Valbazen®) + moxidectin (Cydectin®) + levamisole (Prohibit®, Leva-Med®). Dewormers should not be mixed, as they are not chemically compatible.

As none of these dewormers are FDA-approved for goats, veterinary approval is required for this strategy. Any time a dewormer that is not labeled for goats is given or a labeled product is given at a higher dose, veterinary approval is required. Goat producers need to have a valid Veterinarian-Client-Patient Relationship (VCPR) in order to use drugs extra-label, even if the drugs can be purchased over-the-counter. It is not possible to establish a VCPR online or via the telephone.

It is essential that combination treatments only be administered to clinically-parasitized animals, as determined by the FAMACHA© system, Five Point Check®, or other performance indicators. If combination treatments are administered to all animals in a group or herd, resistance will develop rapidly to all drugs in the combination treatment. The withdrawal period of a combination treatment is the withdrawal period of the dewormer with the longest withdrawal period (usually Cydectin®).

Sericea Lespedeza

Sericea lespedeza (lespedeza cuneate) is a tannin-rich warm season perennial legume. It has been called "poor man's alfalfa" because it grows on marginal soils with minimal inputs. It is especially well-adapted to the warm, moist climate of the southern and eastern US. However, it is important to note that sericea lespedeza is classified as a noxious weed in some states (Kansas and Missouri) and is considered weedy or invasive in some 30 states.

Research conducted over the past 10-15 years has demonstrated that sericea lespedeza has anti-parasitic effects against the barber pole worm, as well as coccidia (Eimeria spp.). It can be grazed, fed as hay, processed into whole plant or leaf meal pellets, or ensiled; processing does not seem to alter its anti-parasitic properties. Including SL in the diet of goats has the potential to reduce parasitism.

Targeted Selective Treatment (TST)

Targeted selective treatment is now widely accepted as a means to slow the rate by which worms develop resistance to the drugs. TST means only deworming those animals that require treatment (or would benefit from treatment). TST reduces deworming frequency and increases "refugia." Refugia are worms that have not been exposed to drug treatment. They are paramount to maintaining dewormer efficacy.

Several tools exist for implementing TST on farms. The FAMACHA© eye anemia system identifies animals that require deworming by using a scorecard to estimate the level of anemia in the animal. Anemia (pale mucous membranes) is the primary symptom of the barber pole worm. The color of the lower eyelid is examined and matched to the FAMACHA© scale; 1-5, with 1 being red (no anemia), 3 being pink (marginal) and 5 being white (very anemic). In order to receive a FAMACHA© card, producers must participate in approved training.

It is generally recommended that goats with FAMACHA© scores of 1 and 2 not be treated, whereas goats with FAMACHA© scores of 4, or 5 be treated. While some producers don't routinely treat FAMACHA© scores 3, it is advised that kids and periparturient does with FAMACHA© scores of 3 be treated.

Because the FAMACHA© system is only effective for blood-feeding parasites, such as the barber pole worm, the Five Point Check© was developed as an extension of the FAMACHA© system. It incorporates five checkpoints on the animal's body, which allows assessment for all parasites commonly affecting small ruminants. The five check points are 1) eye; 2) jaw; 3) back; 4) tail; and 5) nose. The eye (lower eyelid) [1] is examined for the determination of the FAMACHA© score. The jaw [2] is examined for the presence of bottle jaw (accumulation of fluid under the jaw). The back [3] is examined to determine body condition score (1-5). The tail [4] is observed for scours (diarrhea). Poor body condition score and diarrhea are both signs of parasitism, especially with the scour-causing worms. The nose [5] is the final checkpoint. Nasal discharge may be indicative of nasal bots (bot flies) in sheep. Goat producers can replace the nose checkpoint with a coat condition score [5a], as a poor quality hair coat could be indicative of disease. The Five-Point Check® is especially useful for determining the need to deworm goats with FAMACHA© scores of 3.

In situations where the barber pole worm is not the primary parasite, other indicators of parasitism can be used to make deworming decisions. The "Happy Factor" is a model whereby an animal's growth performance is matched to a mathematical prediction of its performance. If the animal fails to reach its performance target, it is dewormed. The "Happy Factor" can be applied in a less sophisticated way. A farm in Maryland received a SARE grant to compare average daily gain (ADG) to FAMACHA© for making deworming decisions. In the first year of their study, ADG was in agreement with FAMACHA© scores 70 percent of the time.

Other performance indicators can be used to determine the deworming needs. In dairy goats, it is common to deworm does with higher performance, as they are under the most stress. UK researchers used litter size as a criterion for managing the parasite risk of periparturient ewes, recognizing that single-bearing ewes are at less risk for parasitism than twin-bearing ewes, but that triplet-bearing ewes are at the greatest risk. Australian researchers have used body condition score as a criterion for deworming, only deworming ewes at the lowest end of the condition scale. Fecal egg counts can be an indicator of parasitism, but they should only be used in combination with other criteria. In Latin America, researchers have combined FAMACHA© scores with FEC to make deworming decisions.

Other

Duddingtonia flagrans is a naturally occurring fungus with anti-parasitic effects. When the spores are fed to livestock, they pass through the digestive system into the manure, where they are activated when parasitic worm larvae become active. They trap, paralyze and kill worm larvae. They have no effect on the host animal. It is anticipated that the fungus (BioWorma) will be licensed for use in the US in 2018, giving producers another tool for controlling internal parasites (The Land, 2018).

No other natural remedies have been determined to be consistently effective at controlling internal parasites in small ruminants. Organic producers and those who use natural remedies are encouraged to continually monitor their animals and administer effective dewormers to those that are clinically parasitized.

Conclusion

No single practice will likely control internal parasites in a goat herd. A combination of practices will usually be necessary to achieve a satisfactory level of parasite control. The Southern Consortium for Small Ruminant Parasite Control (ACSPRC) was organized in 2000. The name was changed to American as the membership expanded. The consortium is a group of scientists, veterinarians, and extension specialists devoted to (1) developing novel methods for sustainable control of gastro-intestinal nematodes in small ruminants and (2) educating the stakeholders in the small ruminant industry on the most up-to-date methods and recommendations for control of gastrointestinal nematodes.

Soon after being organized, the consortium established a web site to disseminate research-based information to producers and those who advise producers. The web site is intended to be the go-to place for information about parasite control in small ruminants. The consortium is in the process of developing a set of twelve fact sheets, "Best Management Practices for Controlling Internal Parasites in Small Ruminants." All fact sheets will be written and reviewed by members of the

consortium. From August 2013-November 2017, the consortium published 58 "Timely Topics" to the web site. These articles were written by members of the consortium and are archived on the web site. They are also in the process of being developed as fact sheets. The web site also includes an image gallery and video library. The resources on the ACSRPC website are for information purposes only and do not replace veterinary advice.

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