Deadly Helminthiasis

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Helminthiasis is an expensive management problem in sheep and goat industry, because the gastrointestinal parasites develop resistance against all anthelmintic chemical products which are discovered and produced by the pharmaceutical industry. The use of natural tannin containing forages such as Sericea Lespedeza is highly promising. Helminthiasis is the invasion of internal parasites into the GI tract of domestic animals, even in humans, causing serious deadly consequences. Sheep and goats are more seriously afflicted than other farm animals. Helminthiasis results in high mortality rate, and poor growth rates, low reproductive performances and low quality products produced from infected animals, which increase high production costs. Anthelmintic drug has been used as the most common control method against gastrointestinal nematodes (GIN) infection. Overuse and misuse of these drugs caused significant GIN resistance against the drugs, especially in sheep and goat production.

Keywords: Helminthiasis, anthelmintic drugs, resistance ; tannin, ; Sericea Lespedeza

1. Introduction

Helminthiasis is the invasion and destructive life of internal parasitic worms into the gastrointestinal tracts of domesticated animals, and even humans, often with serious, even deadly, consequences. Many different endoparasite species can be found in sheep and goats worldwide, and sheep and goats are more seriously afflicted than other farm animals [1]. Millions of dollars are lost in decreased milk and meat production, reproduction failure, treatment costs and deaths. The use of anthelminthic drugs has been the main avenue for control. However, their use is limited by the occurrence of resistance to drugs. As they affect the parasitic worms incompletely, those left over produce pharmaceutical drug resistance against further treatment with the same drug. The pharmaceutical recommendation is that one must change from one to another drug at the next treatment, which needs to occur before the next reproductive cycle of the principle worm species, or use several de-wormer drugs in combination [2]. Thus, the fighting of the helminthiatic conditions of endoparasitic worms is complicated by the development and existence of pharmaceutical resistance, specifically de-wormer drug resistance.

Helminthiasis is attributed to poor growth rates, reduced reproductive performances, increased mortality, and low-quality products from infected ruminant animals, which eventually increase production costs [3]. These parasitic problems are worse in tropical and subtropical regions because of the high prevalence of infected pastures due to favorable environmental conditions for parasites to survive in their free-living stage [4]. Historically, anthelmintic drug treatment has been the most common control method against gastrointestinal nematodes (GIN) infection. However, there has been overuse and misuse of this approach for the last 4–5 decades, which has led to a worldwide increase in the prevalence of anthelmintic resistance among major nematode species in small ruminants [5][6][7]. Over 90% of goat farms had high levels of GIN resistance to ivermectin and albendazole in a report from Georgia [8]. More recently, Howell et al. (2008) [9] reported total anthelmintic failure (resistance to all available anthelmintics) on 17% of sheep and goat farms throughout the southeastern USA.

2. Drugs

There are at least a dozen different anthelmintic drugs in three major categories available for use by veterinarians and farmers [10]. In the category of Benzimidazoles, there is Fenbendazole, then Albendazole and Oxydendazole. Among the nicotinic agonists used are Levamisole, Morantel and Pyrantel, and among the macrocyclic lactones are Ivermectin, Doramectin, Eprinomectin and Moxidectin. These are the current drug names, and they are marketed under different tradenames for the most popular ones—Benzimidasole, Levamisole and Ivomec—until new ones are developed because of the problem of resistance. Recent studies of existing pharmaceutical resistance in sheep (14 farms) and goats (20 farms) in Maryland, Virginia and Georgia, USA [10] showed in the period 2008–2009 that 80% of all farms showed resistance to Ivermectin, 95% to Benzimidazole, 40% to Moxidectin, 20% to Levamisole, and 10% to all the drugs. Since then, in the last 10 years, the percentages had increased to 100, 97, 83, 50 and 33%. Thus, the effectiveness of current de-wormer drugs is decreasing, and when it falls below 50% it is no longer useful. The general recommendation had been to rotate among different antihelmintic drugs, but new research [2] in New Zealand has shown that combining several drugs is more effective.

3. Tannin Contents

Goats are more sensitive to parasitic gastrointestinal nematodes and helminth infections than cattle or sheep [11]. In addition, goats are not grazers like sheep and cattle, but they are, by nature, browsers, consuming preferentially tree leaves, twigs, bark, vines and bushes, which can mean less exposure to parasites, and consequently lower intestinal worm egg numbers in affected goats. However, goats also often host different internal species of parasites than sheep or cattle, therefore medications and nutritional control programs need to be specific to goats and are not appropriate to transfer from sheep and cattle [10]. Furthermore, goats have a different nutrition from sheep and cattle [12] including tolerance of plants with tannin contents [13], while sheep and cattle avoid tannin, do not tolerate tannin-containing plants, and may have depressed efficiency of their dietary energy utilization in the presence of tannins [14]. Tree leaves and bark have tannin content and this makes goats nutritionally more similar to deer, and they are not "small cows", as has been a popular attitude among scientists when nutritional or medical programs are needed. A recent study with different breeds of goats [15] showed genetic differences in the tolerance or even the selection of tannin-containing plants. Damascus goats under freely grazing conditions consumed three times more the tannin-rich Pistacia lenticus plant (116.4 g/day tannin) than their herdmate Mamber goats or crossbred Alpine goats. They also, under grazing conditions, produced higher milk protein (3.37%) and milk fat (6.12%) compositions and especially, in terms of human health potential, more medium chain fatty acids, more monounsaturated fatty acids (MUFA), 20% richer in omega 3 fatty acids and lower in the omega 6/omega 3 ratio.

The use of herbal medicines containing phenolic compounds as part of tannin contents has had wide native use in some countries, like Brazil [16]. Recent studies with tannin extracts from Spigelia anthelmia showed a 100% inhibition of motility with ovicidal and larvicidal effects on the dominant nematode Haemonchus contortus, thus promising efficacy in helminth control. Phytochemical studies identified the alkaloid spiganthine as the major component responsible for the nematicidal activity of the herbal extract.

One of the most extensive studies about tannin involved Sericea Lespedeza with goats was conducted at the Agricultural Research Station Fort Valley, Georgia, USA [17]. Lespedeza is a perennial warm-season, drought-resistant legume forage and popular with soil conservation programs, but not with farmers trying to use it as pasture for cattle and sheep, because the tannin content makes it less palatable, while goats actually like it. Growth trials with 40 intact Kiko X Spanish male goats, 6 months old [18], showed the Lespedeza hay-fed goats to have a significantly greater average daily weight gain of 104 g/day over the 98-day long trial period compared to 76 g/day for the Bermudagrass-fed goats. The difference in better weight gain was explained by the significantly greater daily dry matter intake from Lespedeza hay (4.94 kg/day/pen) compared to 3.25 kg for the Bermuda grass hay group. Rumen fluid analyses also indicated that the Lespedeza-fed goats had a more efficient protein metabolism than the Bermudagrass fed goats, higher rumen volatile fatty acids (VFA) concentrations and lower acetate:proprionate ratios. Finally, the Lespedeza hay-fed goats had significantly lower fecal egg counts always.

Additional trials with 30 growing male Spanish goats, 9 months old [19], using Sericea Lespedeza hay pellets as a 75% or 95% supplement showed after 11 weeks grazing that on slaughter and carcass analyses the Lespedeza goats had significantly lower fecal egg counts than the goats fed commercial pellets. They also had significantly fewer nematodes in the abomasum and small intestine. Compared to the growing goats fed the commercial supplement, the reduction in fecal egg counts in the growing Lespedeza goats was 95% and 84% for the two Lespedeza leaf meal supplement levels, 95% and 75% in the daily ration, respectively (Table 1), and especially for the main parasite Haemonchus contortus.

Table 1. Fecal egg count of growing goats grazing and supplemented with commercial pellets or 75% Lespedeza leaf meal or 95% Lespedeza leaf meal (adapted from [19]).

Fecal Egg Count (Eggs/Gram Feces)			
Days after Start	**Commercial**	**75% Supplement**	**95% Supplement**
0	0	0	0

14	500	600	500
21	650	700	550
28	700	650	500
35	1000	600	400
42	950	550	300
49	1100	500	250
56	1400	400	200
63	1500	300	100
70	1600	250	100
77	1600	200	100

In addition to the antiparasitic effect of lowering fecal egg counts in the experimental goats, Sericea-Lespedeza-supplemented feeding significantly enhanced animal performance, such as in final body weight, daily weight gain and post-slaughter shrinkage in chevon meats, as shown in Table 2 [19]. Initial live weights of the goats were similar, but final live weights and shrink weights following pre-slaughter feed withdrawal were higher (p < 0.05) for goats fed 95% SL leaf meal pellets compared with animals given 75% SL pellets (Table 2) [19]. The average weight gain per day was also revealed to be significantly higher (p < 0.05) for the 95% SL pellet-fed group compared to the 75% SL group. Even if the differences were not statistically significant, final and shrink weights and average daily gains of the control animals were lower than for the 95% SL pellet group and greater than for the 75% SL-fed animals. There was no significant difference between carcass weights of all three treatment groups.

Table 2. Average body weight, daily gain, and post-slaughter shrink weight in growing goats' grazing. perennial summer grass pasture supplemented with 95% sericea lespedeza (SL) leaf meal, 75% SL leaf meal, or commercial pellets (adapted from [19]).

Pellet	**Body Weights (kg)**				
	Initial Live wt	**Final Live wt**	**Gain per Day (g)**	**Shrink wt**	**Carcass wt**
Commercial	20.4 ± 0.95 [a,*]	26.1 ± 1.20 [a,b]	77.2 ± 0.5 [a,b]	24.9 ± 1.18 [a,b]	16.2 ± 0.63 [a]
75% SL leaf meal	19.7 ± 0.85 [a]	23.7 ± 1.07 [b]	53.3 ± 9.43 [b]	23.4 ± 1.06 [b]	15.1 ± 0.56 [a]
95% SL leaf meal	21.2 ± 1.02 [a]	29.6 ± 1.28 [a]	102.0 ± 11.2 [a]	27.8 ± 1.27 [a]	16.8 ± 0.67 [a]

[a,b] Means with different superscripts within a same column are different at p < 0.05.

In addition to the problem with nematodes there can also be a threat from coccidia (*Eimeria sp.*) to the health and productivity from small ruminants, especially young animals, whose immune system has not matured. Under favorable conditions such as transportation stress, there can be an outbreak of coccidiosis in a flock, with serious symptoms of diarrhea, dehydration and death [20]. In two studies with 24 Kiko-cross bucks and with 20 Spanish bucks, 16 and 20 weeks old, respectively, diets were supplemented with 90% lespedeza leaf meal pellets. Fecal egg counts and fecal oocyst counts both decreased again significantly in both studies. Coproculture analyses showed severe reductions in

Teladosagia circumcincta, Trichostrongylus colubriformis as well as Haemonchus contortus, on days 7 to 28 for both studies down to zero. There are few reports in the literature on the use of plants to control Eimeria coccidia, all of them containing tannin such as Melia azedarach or Pistacia lentiscus, besides Sericea lespedeza, which has been effective on fresh green grazing or when fed dry as hay, leaf meal or pellets. The authors concluded that lespedeza provides a valuable environmentally friendly tool for improving the health and productivity of young goats in contrast to the chemical anthelmintic drug treatments with their build-up of resistance in the parasites and the danger of residues in meat and milk of treated animals. Lespedeza has great potential for both the prevention and treatment of coccidiosis or mixed infections of Eimeria and nematodes in young goats.

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