Efficacies of fenbendazole and albendazole in the treatment of commercial turkeys artificially infected with *Ascaridia dissimilis*

Jessica Perkins, Thomas Yazwinski, Chris Tucker

Abstract

The goal of this research was to determine the extent of anthelmintic resistance that turkey roundworms, *Ascaridia dissimilis*, have developed to anti-parasitic chemicals used in commercial turkey operations. Roundworm infections in turkeys have resulted in monetary losses for the poultry industry for years, due to poor feed conversion. The infection itself is generally subclinical and many turkeys have a light to moderate worm burden. Since parasitisms are light, this leads to the infections being noticed only during processing. *A. dissimilis* infections consist of adult worms and developing larvae with the latter comprising most of the worm burden and causing the most damage. In this study, eggs were collected from *A. dissimilis* found in turkeys previously treated with various parasiticides and combinations thereof. These eggs were in turn used to instill artificial infections in turkeys on site. These artificially infected turkeys were then treated with fenbendazole or albendazole. A third group of birds were left untreated as a control group. Drug efficacies were determined based on parasite loads post treatment (at necropsy). The results of this study will improve current knowledge of anthelmintic resistance associated with these drugs.

Introduction

The economic losses due to infections of *A. dissimilis* can be significant. Poor feed conversion, a common impact of parasitism, makes it difficult for turkeys to gain weight. This results in low market weight and in some extreme cases, it can result in damaged livers that cannot be sold, contributing to even lower profits (Willoughby et al., 1995).

Turkey producers have been using numerous chemicals for treating *A. dissimilis* throughout the years, all with varying success rates. Poor results with anthelmintic drugs can be related to chemical resistance. Resistance results from a product killing off a large percentage of the worm population, but leaving a very small percentage that may not be susceptible to that particular product. This resistant population continues to reproduce, creating a new population of worms that are not affected by the product.

Ascaridia dissimilis has a direct life cycle with no intermediate host. The eggs are laid by adults in the small intestine and are shed into the environment through droppings. Larvae develop inside the eggs and become infective within a few weeks (Seaton et al., 2001).The first larval stage is developed inside the egg after approximately one week. After another 20 days, the larva develops into a second-stage larva, which is infective to the turkeys (Seaton et al., 2001). After ingestion, the larvae emerge from the eggs in the anterior portion of the intestinal tract, and localize against the mucosa in the small intestine. After approximately two weeks, they molt to the third stage with some larvae migrating into the mucosa and submucosa (“tissue phase”) while the remainder of the larvae stay in the mucus. After another two to three weeks, the larvae develop into fourth stage larvae which in turn develop into adults. With naturally infected birds, a residual population of third stage larvae is maintained.

Damage to the mucosa can result in hemorrhagic enteritis. Nutrients are not digested optimally, contributing to poor feed conversion and low market weight (Willoughby et al., 1995). Occasionally, *A. dissimilis* larvae have been observed in the livers of turkeys, causing an immune response that results in 1-mm white spots on the surface of the liver (Aziz and Norton, 2004). With heavy infections, the migration of developing larvae in the mucosa can result in death whereas adults can block the intestinal lumen.

Piperazines are only partially effective against adult worms and repeat treatment is required for any real benefit to the bird. The drug has been overused throughout the years and studies have revealed that piperazine severely lacks efficacy (Yazwinski, 1999).

Fenbendazole is a benzimidazole anthelmintic used to treat birds for helminth infections. It is FDA approved for turkeys and has long been considered effective against both the larvae and the adult worms. Recently poultry producers have begun to notice increased resistance to it. No studies have been published as of yet regarding the current efficacy of fenbendazole in turkeys. This study will therefore provide timely information on the effectiveness of this product.

Albendazole is another benzimidazole anthelmintic used to remove gastrointestinal worms. It is a "prescription-only" drug for poultry and has not been evaluated by the FDA for use in commercial turkeys to treat for ascarid infections (Tucker et al., 2007). Albendazole and fenbendazole both work through inhibiting microtubule polymerization. This restricts nematode glucose utilization and the worms lack the energy to survive.

Materials and Methods

*Collection of Ascaridia dissimilis eggs and incubation***.** Approximately one hundred intestinal tracts containing *A. dissimilis* were shipped overnight to the University of Arkansas from four separate turkey operations in the USA. Each turkey operation used a different chemical regimen for treating ascarid infections. The intestinal tracts were cut open lengthwise, the contents removed and sieved, and all mature female *A. dissimilis* were collected. Eggs were removed from the uteri of the female *A. dissimilis*, washed and incubated at 30 °C in water until reaching the infective larval stage (approximately 30 days).

Brooding and infection of turkeys. One hundred and fifty, one day old turkeys were obtained from a Cargill hatchery in Gentry, AR and were brought back to a University of Arkansas poultry growing facility. At 7 days of age, each bird was wing tagged with a unique identification number. Throughout brooding, the turkeys were moved into new pens to allow for adequate space.

At 14 days of age, and again at 28 days of age, birds were orally gavaged with source specific infective eggs of *A. dissimilis* (approximately 40 birds per source and 1000 eggs per dose). At 45 days of age, birds were treated according to random selection within each infection source group. Treatments equally applied per group were fenbendazole suspension (5 mg/kg BW), albendazole suspension (5 mg/kg BW) and control (no treatment). For each benzimidazole, a stock solution with a concentration of 5 mg/ml was made for commercially available products (10% fenbendazole suspension [Safe Guard], 11.36% albendazole solution [Valbazen]). On the day of treatment, each bird was weighed and treated at the volumetric rate of 1 ml/kgBW, with the total dose given in halves with a six hour interval. Humane euthanasia by cervical dislocation occurred at 52 days of age. The intestinal tracts were removed from the duodenal/gizzard junction to the rectum as per WAAVP efficacy evaluation guidelines (Yazwinski et al., 2003) and sent to the parasitology lab at the University of Arkansas to be processed for nematode enumeration.

Collecting Ascaridia dissimilis. Intestinal tracts from the birds were cut open lengthwise and soaked overnight to optimize nematode collection. After soaking, the intestines were drawn through a tightly clenched fist to remove all contents. These contents were then washed over a number 200 sieve (aperture of 75 μm). All *A. dissimilis* recovered were identified and counted to developmental stage.

Statistics. Individual bird infections by *A. dissimilis* (adult and larval forms combined) were transformed to the $\log_{10}(X+1)$ prior to analysis of variance to note group mean separations at the 5% level of probability. This transformation is the norm for data sets where large variability is encountered between individual counts within populations. Data is presented as arithmetic means and geometric means, with the later given with significant mean separations.

Results and Discussion

Data collected was organized per treatment group with attention given to total larvae, total adult worms, total worm burden, average worm burden and overall efficacy of treatment.

According to WAAVP guidelines, to be considered “effective”, anthelmintic drugs must have a >90% efficacy. Regardless of infection source, most of the treatments in this study could be considered effective. In previous studies, fenbendazole was demonstrated to be 97% to 99% effective against all stages of *A. dissimilis* (Yazwinski et al., 1993 and 2009). In comparison, birds treated with fenbendazole in this study had much lower efficacy percentages (source dependent efficacies of 26.8%, 54.9%, 80.9% and 83.6%). Albendazole exhibited an efficacy >90% in only one situation (source dependent efficacies of 0%, 5.1%, 78.3% and 92.3%).

The less than efficacious anthelmintic efficacies of fenbendazole and albendazole as seen in this study may indicate a rising resistance to benzimidazoles in *A. dissimilis* populations. Resistance in a pathogen population to chemicals used for control is a natural result of most intervention programs. Given the apparent reduction of benzimidazole efficacies in the treatment of *A. dissimilis* infections, altered or different treatments must be investigated so that this common disease condition of commercial turkeys might once again be effectively controlled.

Literature Cited

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Figure 1: Life stages of *Ascaridia dissimilis*.

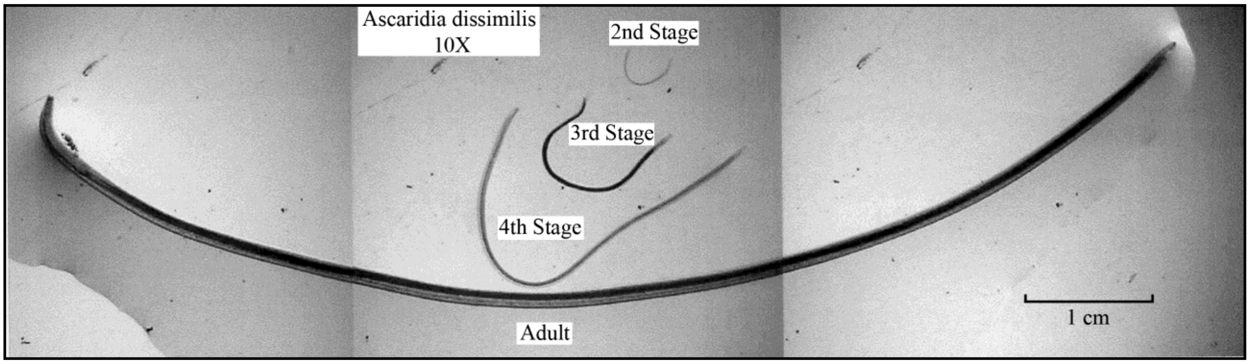

Figure 2: *Ascaridia dissimilis* egg. Approximately 30 microns by 80 microns.

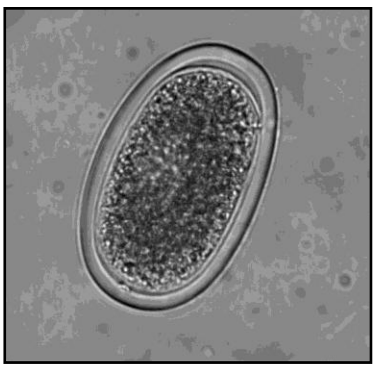

Table 1. Description of experimental groups used in this study.

Source	Field treatment	Birds per group	Study treatment
A	Albendazole	11	Control
		13	Fenbendazole
		13	Albendazole
B	Fenbendazole	12	Control
		12	Fenbendazole
		13	Albendazole
C	Piperazine	12	Control
		12	Fenbendazole
		13	Albendazole
D	Piperazine & Albendazole	12	Control
		13	Fenbendazole
		13	Albendazole

Table 2. Arithmetic means (SD) for adult and larval (L4 & L3) *A. dissimilis* populations by source of isolate and treatment group.

Source	Treatment Group	*A. dissimilis* as: Adult	Larvae	Total
A	Control	11.1 (12.6)	17.9 (16.5)	28.2 (22.4)
	Albendazole	2.8 (1.8)	2.3 (3.4)	5.1 (4.4)
	Fenbendazole	2.3 (2.4)	1.8 (2.2)	4.1 (2.9)
B	Control	11.4 (15.0)	15.8 (12.3)	27.3 (19.6)
	Albendazole	2.1 (3.1)	1.5 (2.0)	3.5 (4.8)
	Fenbendazole	2.3 (1.9)	3.5 (5.1)	5.8 (5.8)
C	Control	5.3 (3.6)	11.8 (13.3)	17.1 (12.5)
	Albendazole	20.2 (26.9)	5.2 (5.9)	25.5 (27.3)
	Fenbendazole	8.3 (10.8)	7.5 (12.7)	15.8 (16.1)
D	Control	6.3 (9.4)	1.5 (1.7)	7.8 (9.1)
	Albendazole	4.6 (5.1)	2.0 (2.6)	6.6 (5.1)
	Fenbendazole	2.6 (4.2)	1.6 (2.4)	4.2 (5.1)

Table 3. Geometric means for *A. dissimilis* (adult and larval stages combined) by source of isolate and treatment group.

Source	Treatment Group: Control	Albendazole	Fenbendazole
A	17.06^{a}	3.71^{b}	3.26^{b}
B	23.11^{a}	1.74^{b}	3.79^{b}
C	13.82	17.45	10.14
D	5.10	4.84	2.30

^{a,b} Means on the same line with different superscripts are different ($P \leq 0.05$)

Table 4. Percent efficacies against *A. dissimilis* by source of isolate and treatment (based on geometric means).

Source	% efficacy for Albendazole	Fenbendazole
A	78.3	80.9
B	92.3	83.6
C	0.0	26.6
D	5.1	54.9