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Pharmacological Treatment of Giardiasis

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Abstract

Giardiasis is a disease caused for a myoflagellate protozoan known as *Giardia duodenalis*, of which varieties have been described and whose morphological characteristics are identical to other species such as *G. lamblia* and *G. intestinalis*; considered for various authors as the same species, this protozoan parasites several domestic species including man, but has important relevance in the canine and feline species, due to their zoonotic potential. In recent years, the number of cases of canine and feline giardiasis has increased, not only because it is treated of a cosmopolitan parasite, which is closely related to unsanitary conditions, but also because the conventional treatments for its control and eradication have shown resistance phenomena. It is for this reason and being a parasite of potential zoonotic risk that at present pharmacological tests have been developed in the search for new alternatives for the treatment of giardiasis, especially in the canine and feline species as mentioned earlier.

Keywords: benzimidazoles, *Giardia intestinalis*, imidazoles, nitazoxanide, teclozan

1. Introduction

Giardiasis is a parasitic disease, caused by a protozoan called *Giardia duodenalis*, which shares similar morphological characteristics with other species such as *G. lamblia* and *G. intestinal*, for which the same pathogen has been considered [1–3]; this protozoan affects many domestic and wild species [2]. In the canine and feline species, it is described as *G. intestinalis* [1, 2], previously described as *Giardia canis*; this protozoan affects not only animals but also man [4].

Epidemiology has been considered a cosmopolitan parasite, which causes malabsorption syndrome in the host, causing gastroenteritis in these patients [1, 4], due to the presence of giardia in intestinal mucosa, producing ulcerative lesions and hemorrhagic, it should be made clear that, not being an agent considered cosmopolitan, it does not affect the species of cattle such

as cattle, goats, sheep, and swine [1, 2, 4], it is a seriously pathogenic agent for animal species, that if it causes injuries that produce a consuming disease, considered as a zoonotic disease of global importance [2].

The prevalence is higher in areas with unhealthy conditions [3, 5], where the presence of excreta in the water, excreta management, overcrowding, and warm conditions has been described, favoring the presence of an agent [6]. Transmission is oro-fecal; humans, canines, and felines ingest the infecting cysts [2, 3], which hatch and develop into gastroenteritis later on. This route allows the outbreaks between dogs and humans frequently, especially in rural areas and shelter canines [7, 8].

It is important to introduce ourselves in the treatment, to comment on the typical clinical signs of the disease, these are due to gastroenteritis [2], due to damage of the villi of the intestine, leading to malabsorption syndrome [8–10], this type of gastroenteritis causes not only typical diarrhea with mucus, odor, and steatorrhea, but also abdominal discomfort, vomiting, nausea, regurgitation, and anorexia. This is why it is important to use drugs that are not only extremely effective (greater than 95% effectiveness) but also the least gastrolesive or irritant.

For the treatment of giardiasis, there are a number of drugs approved by the Food and Drug Administration (FDA), which are described in the Plumb and Papich therapeutic manuals [11, 12]. It is important that it is established which drugs have kinetic studies in animal species, because sometimes pharmacological products are used, which has few studies in domestic species and if we speak of a health picture, not only high morbidity but zoonotic, it should be clear that products can be formulated and what are their therapeutic indications, according to previous studies.

The drugs used for the curative treatment of *G. intestinalis* will be categorized into pharmacological groups, which will indicate their most relevant pharmacological characteristics, such as the mechanism by which the agent is eliminated, its kinetic behavior, contraindications to be taken into account when given, and the dose suggested by the effectiveness studies.

The prevalence of *G. intestinalis* in canines of Colombia is unknown, since the studies described for the canine species are pitifully isolated, whereas in other parts of world, it has been estimated that the prevalence is at 7% and for South America, the prevalence is 27.6%. In Colombia, Alarcón et al. (2015) reported a prevalence of 0.81% in a study with 122 samples of fecal matter in Bogotá, whereas Caraballo et al. (2007) in the center of veterinary medicine and zootechnics CES, Envigado, Colombia, reported a prevalence of 13.9%, compared with research in 22 canine refuges that Sierra-Cifuentes et al. (2015) conducted and a prevalence of 6.8 and 10.3% for the municipality of Medellín and Oriente Antioqueño, respectively.

2. Therapeutic of giardiasis

2.1. Nitroimidazole

This group of drugs is the most described for the treatment of giardiasis, in many countries of the world, both for dogs and for cats, and is one of the most described pharmacological products in the treatment of giardiasis in humans [13–15].

Nitroimidazole class drugs, which are considered to be anti-Giardia, have some limitations in domestic species, especially in small animals, where their toxic effects on the central nervous system (CNS) have been described when close doses have been used at 50 mg/kg [16], especially in felines; other authors suggest not exceeding the dose of 25 mg/kg in felines [11].

Within the nitroimidazole family of drugs, metronidazole, secnidazole, tinidazole, and dimetridazole are frequently used in the treatment of intestinal protozoa, such as *Entamoeba histolytica*, *Trichomona fetus*, and *G. intestinalis*, in some animal species and in man [17–19]. As for the treatments of giardiasis, we will try to elucidate which are the most updated therapies for the treatment of these parasites. To understand this group of drugs and as their routine use is important to understand the mechanism of action, nitroimidazoles have antibacterial and antiprotozoal mechanism of action and generate nitrogen radicals, which affect the metabolism of the parasite or bacteria. These drugs disrupt the DNA of organisms through a reaction with intracellular metabolites [11, 12, 17].

With regard to their pharmacological characteristics, the oral absorption of nitroimidazoles is almost complete by the oral route, but are somewhat gastrolesivos, especially in humans which cause anorexia and give a metallic taste to the mouth [20]; in horses, their bioavailability is of 75–100%, whereas in felines and canines, it is 60–100% [12] in dogs. This group of drugs has variable mean lives according to the species: 2–4 h in horses, 9–12 h in foals, 4–5 h in dogs, and 4.8 h in cats [12, 17, 21], given mainly in urine [18]. In cats, metronidazole benzoate salt has been used or suggested, which improves palatability.

As for the adverse effects of these drugs, CNS toxicity is described mainly by several authors; as mentioned previously, doses close to 50 mg/kg cause especially in feline states of lethargy, depression, ataxia, incoordination, tremors, vomiting, weakness, and clonic seizures. The explanation of this phenomenon of drug toxicity is mainly due to the fact that nitroimidazoles cause an inhibition of gamma butyric acid (GABA). Peripheral neuropathic lesions can also be frequent in doses higher than 25 mg/kg [11, 12, 16].

Due to their hepatic metabolism that is achieved by the action of cytochrome P450, by hydroxylation, and conjugation with glucuronic acid, they can cause toxic liver diseases after continuous use [18]. It is important to emphasize that by their oral presentation, these drugs have the property of causing states of inappetence, especially in dogs and cats [17, 18], so their use has been lost for the treatment of giardiasis in these species, because the agent of per se causes inappetence which can be potentiated, after the use of these drugs.

It is important to document that these drugs are mutagenic and teratogenic and therefore should not be used in pregnant females. It is also important to note that the addition of salts to improve the taste can also cause harmful effects especially in cats that are intolerant to acid derivatives, benzoic acid [12].

Regarding therapeutics, it has been described that metronidazole is 100% effective for the treatment of giardia enteritis; the explanation is based not only on its ability to eliminate other common agents such as amoebas and trichomonas, which may be parasitizing concomitantly, but also on its property of inhibiting the lymphocytic response behaving as an intestinal anti-inflammatory at the same time [16, 17].

The recommended dose for domestic species varies according to the drug, species and agent to be treated, as for metronidazole, 22 mg/kg every 12 h for 5 days [11, 21]; for canines, Papich suggests not exceeding 15 mg/kg every 12 h for 8 days; and in cats, it is suggested 10–25 mg/kg every 12 h for 8 days [11, 12, 21, 22]. Other authors recommend an effective dose of 100% for cats of 22–25 mg/kg every 12 h for 5–7 days [16, 23]. For the author, 20 mg/kg has been shown to be an effective dose for canines and felines every 12 h for 5 days [17].

Other nitroimidazoles such as tinidazole 44 mg/kg every 24 h for 3 days have also been used in small animals [21]; while Papich only indicates that 15 mg/kg every 12 h for 5 days is sufficient for dogs and cats [22], secnidazole 30 mg/kg single dose is recommended in a study conducted in a canine shelter and found effectiveness of 725 with a single dose [24].

Other nitroimidazoles, such as ipronidazole, ornidazole, and ronidazole, which have been used in the treatment of giardiasis in a small number of animals, some medicated in drinking water, have been suggested for use in birds than for canines and felines [17–19].

2.2. Benzimidazoles

The benzimidazoles are a group of drugs that have frequently been used for the treatment of parasitic nematodes mainly, although their effectiveness in the control of cestodes and trematodes has been evident. Its capacity to eliminate not only the adult forms but also the ovoposición has been the treatment of gastrointestinal parasites in many animal species [17–19], including humans, where this group is of greater importance in the control of giardias [13, 15].

Nowadays, benzimidazoles and especially fenbendazole and its prodrug febantel are considered as the standard drugs for the control of canine and feline giardiasis [25], not only because of its effectiveness, which is 100% [26, 27], but also because they require fewer days of treatment as well as a longer half-life, which facilitates their administration especially in small animals.

Within this group of drugs, there are two that have been shown to be effective for the treatment of *G. intestinalis*, which are fenbendazole and albendazole, the latter widely used in humans for the treatment of giardiasis in children [13, 15, 28].

It is important to document some of the pharmacodynamic properties of the benzimidazoles. Its mechanism of action is to produce the degeneration of the parasite microtubule and irreversibly block the uptake of glucose by the parasite; in this case, *Giardia* spp. inhibit the uptake of glucose causing the depletion of energy reserves in the parasite and eventually resulting in death (Papich). However, there is no effect on host glucose metabolism, in this case mammal, as indicated benzimidazoles have been used for the treatment of giardiasis in many animal species, not only dogs and cats, but also sheep, goats, and calves, which can also be parasitized by this zoonotic agent [11, 12, 22].

Regarding their kinetic behavior, benzimidazoles are absorbed marginally after oral administration; blood levels in calves are 0.11 µg/ml and in horses are 0.07 µg/ml, whereas in canines and felines at levels of up to 0.2 µg/ml, allowing it to have a high volume of distribution [11, 21], reaching sites where the parasites are in a hypobiotic form, hence showing their great quality

in eliminating larvae in the state of hypobiosis. This family of drugs has a hepatic metabolism, by the simple action of the cytochromes P450, being the excretion between 44–50% by feces and 1% by urine.

It is important to describe that febantel is a prodrug, which presents first-pass metabolism, which transforms it after the metabolism in fenbendazole and albendazole, which makes it a very potent anti-giardia, by sum synergism [11, 17].

With regard to the safety of the drugs in this family, it is important to note that they are very safe, with a high safety margin, but they may also have some digestive problems such as vomiting and diarrhea, especially when doses higher than those suggested are given or intervals increased, such as three to five times a day [11, 12, 22]. In terms of renal and hepatic safety, the author has found that benzimidazoles are very safe for both kidney and liver and are also very safe during gestation and lactation; no known contraindications for domestic species have been described and used at any age [11, 17, 22].

Benzimidazole treatment for the management of *G. intestinalis* is based on three pharmacological products: fenbendazole, albendazole, and febantel; the treatment is with fenbendazole [26] or febantel [29], but due to constant reinfection and resistance phenomena, these have lost effectiveness. Goniostasis in canines can be treated with fenbendazole at a dose of 50 mg/kg as described by Barr et al. (1994); Zajac et al. (1998) [1], which has now been considered the treatment standard because it has a 100% effectiveness. This description is similar to those given by other authors but in species such as sheep (*Ovis orientalis*), where at a dose of 10 mg/kg once daily for three days is equally effective that in canines [30]; some authors, in particular Geurden et al., suggest that the standard dose in sheep for *G. intestinalis* should be 15 mg/kg every 24 h for 3 days [31]. In *Bos taurus* calves, the dose of fenbendazole is much smaller, where 5 mg/kg every 24 h oral for 3 days is effective in 90% [32].

In a study conducted by Molina, Salazar and Cabreraet (2016), it was found that fenbendazole was 60% effective for the control of *G. intestinalis* cysts and trophozoites at a dose of 50 mg/kg orally every 24 h for 3 days, which is similar to the descriptions made by other authors [30, 33, 34], but discusses the 100% effectiveness that documents for drug authors such as Montoya (2008), Villanueva (2009), and Meltzer, et al (2014) [26, 29, 35].

In cats, the treatment has been found to be effective with febantel 37.8 mg/kg, oral every 24 h for 5 days [23], whereas the dose in canines is equal, 100% effectiveness is achieved with only 3 days of treatment, in which the number of cysts in the proportion discussed above is eliminated [34].

The uses of other benzimidazoles such as albendazole at a dose of 25 mg/kg every 12 h for 4 days have been shown to be effective in killing infected animals [22]. However, therapy with albendazole may cause bone marrow suppression and therefore should be used with caution in canines and felines, in a case of acute giardiasis [22]. In sheep, the use of albendazole at doses of 20 mg/kg oral once daily is sufficient to control *G. intestinalis* [30], a situation very similar in humans.

Other benzimidazoles, such as mebendazole, have been found to be only 37% effective against giardiasis; thus their use is impractical [12].

2.3. Nitrofurans

Some authors have described the use of antibiotics for the treatment of *G. intestinalis*, especially in human therapy, in which the use of furazolidone has been routine for decades; in animal species, some authors such as Papich [22] and Plumb [11] indicate that this antibiotic has effectiveness against the parasite.

The study of the pharmacodynamics of this antibiotic will allow us to understand its giardicidal ability; furazolidone interferes with susceptible bacterial or parasitic enzymatic systems, within which we can indicate that it has activity against *Vibrio cholerae*, *Trichomonas fetus*, *Eimeria* spp., *Isospora* spp., *Neospora* spp., and many strains of *E. coli*, Enterobacter, Campylobacter, Salmonella, and Shigella. This antibiotic also has the property of inhibiting monoamine oxidase [11, 12, 22].

As for pharmacokinetics, the information is somewhat contradictory regarding the absorption characteristics of furazolidone; it is absorbed orally and reaches in the different body fluids, with concentrations sufficient to exert an effective antibacterial action. Its absorption is fast in the small intestine, but prefers media with acid pH, with little water solubility. Its metabolism is hepatic with a half-life of 30 min, and its binding to plasma proteins is 60%, which causes most of it to be excreted in urine [17–19].

The suggested dose for the treatment of giardiasis in dogs and cats is 4 mg/kg, orally every 12 h for 7 days [12, 22]; in the case of cats, it has been recommended that the dose should be given per 10 days [11, 21].

2.4. Quinacrine

This drug is currently one of the least used, basically because of its side effects that are sometimes annoying; this drug has properties and activities against a variety of protozoa and helminths. Its use against all except Giardia and Trichomonas has been replaced by agents safer or more effective [12, 21, 22], as we have already discussed.

In humans, quinacrine may be used for the treatment of mild-to-moderate discoid lupus erythematosis (LE), transcervically as a sterilizing agent, or as a powder as an intrapleural sclerosing agent [11].

As for its mechanism of action, quinacrine has its antiprotozoal activity against Giardia not understood; however, it binds to DNA by intercalation at adjacent base pairs, thus inhibiting RNA transcription and translocation [11, 21, 22]. In addition, quinacrine interferes with electron transport and inhibits the oxidation of succinate and cholinesterase, which binds to nucleoproteins that (in humans at least) can suppress the lupus erythematosis cell factor [11, 21].

To know its pharmacokinetics, this product is absorbed well from the gastrointestinal tract, after the oral administration. It is distributed throughout the body, but CSF levels are only 1–5% of those found in plasma [12, 22]. The drug is concentrated in the liver, spleen, lungs, and adrenals [21]. It is relatively highly limited to plasma proteins in humans (80–90%). This can pass through the placenta, but only small amounts enter the breast milk. The elimination is slow, with a half-life of 5 days, with a slow liver metabolism, being eliminated almost entirely by the kidney, causing acidification of the urine, which increases its excretion via this pathway [11, 21].

It is important to know that is contraindicated its use in behavioral alterations, psoriasis and porphyria, very described in humans, more studies are missing in animals; it is clear that it should be handled with care in patients with hepatic disorders, since jaundice appears in addition to digestive signs such as anorexia, nausea, vomiting, and diarrhea, abnormal behaviors ("biting with fly," agitation), pruritus, and fever. In addition to hypersensitivity, liver disease, anemia, corneal edema, and retinopathy, it should not be used in pregnant females to cross the placental barrier and also has milk elimination. In humans, it is responsible for hydrocephalus, and in rats, the neonatal mortality rate is increased. According to the FDA, this drug is category C, so it should not be used during gestation [11, 22].

While its therapeutic safety is poor, an overdose can cause death; the signs of intoxication are neurological, giving convulsions, delirium, and excitement, in addition to what was described above with gastrointestinal symptoms.

The recommended dosage for canines is 6.6 mg/kg every 12 h for 5 days [36]; other authors recommend 9 mg/kg orally every 24 h for 6 days [21]. For cats, the dose is 9 mg/kg, oral every 24 h for 6 days [37].

2.5. Paromomycin

It is an antibiotic of the aminoglycoside family, whose bactericidal effect is the irreversible inhibition of the 30 S subunit of bacterial chromosomes, preventing the formation of the initiation complex between mRNA and ribosome [17, 18, 38], thereby inhibiting protein synthesis.

This drug is considered as an amebicide and anthelmintic directly by contact, although its mechanism of action is unknown. In human medicine, it has been used for the treatment of mixed enteritis including giardiasis [13, 28]; in addition, it acts as an intestinal bactericide of digestive bacterial flora, including ammonia-producing bacteria [13, 15].

Paromomycin exhibits a broad spectrum of action, including bacteria, protozoa, and helminths. It is active mainly against amoebas such as *E. histolytica*. It also exhibits activity against Gram-negative bacteria and some Gram-positive bacteria such as Staphylococcus strains. It has some activity against *Mycobacterium tuberculosis*, but is totally ineffective in the case of *Pseudomonas aeruginosa*. Finally, it is anthelmintic in case of infections caused by *Diphyllobothrium latum*, *Dipylidium caninum*, *Hymenolepis nana*, *Taenia saginata*, and *Taenia solium* [15].

Regarding pharmacokinetics, after oral administration, absorption may increase in situations in which the permeability of the intestinal mucosa is altered, such as inflammation or erosion of the epithelium [13], and elimination is by feces and via the kidneys slowly [15].

The recommended dosage for canines is 125–160 mg/kg, every 12 h for 5 days [25].

2.6. Nitazoxanide

Nitazoxanide is a synthetic derivative drug of salicylamide, used as a broad-spectrum anti-parasitic agent with proven effectiveness in protozoal infections and worms [9, 39–41]. It is approved for infections by parasites such as *G. lamblia* and Asacarididos in human patients [13, 15]; it is considered an extremely safe pediatric drug [28].

This drug, initially explored in the equine species, was indicated in horses for the treatment of equine protozoal myeloencephalitis (EPM) caused by *Sarcocystis neurone* [11, 21, 22]. In recent years, it has been explored in the canine species for the treatment of *G. intestinalis* [42].

The mechanism of action is to inhibit the enzyme pyruvate ferredoxin oxidoreductase (PFOR), disrupting the metabolism of the parasite; in addition, this mechanism prevents the transference of electrons preventing energy metabolism by the parasite [17]. In helminths, it inhibits the polymerization of tubulin in the parasite.

As far as pharmacokinetic data are concerned, they are well known in equines, where after oral administration, it is absorbed and transformed into tizoxanide (deacetyl-nitazoxanide); the maximum level is reached at 2–3 h; in humans, it is reached at 4 h, 99% of which is bound to plasma proteins [39], excreted by urine and bile, in the form of glucuronic acid [11, 22].

This drug is a prodrug, followed by its rapidly hydrolyzed administration to its active metabolite, tizoxanide, 99% of which binds to blood plasma proteins [39]. Peak concentrations are observed for 1–4 h after administration. It is excreted in the urine, bile, and feces [12]. Its mechanism of action is by the inhibition of tubulin in helminths [11]. In the case of protozoa, electron and biochemical resonance studies have shown that pyruvate ferridoxin oxidoreductase (PFOR) and, to a lesser extent, hydrogenase reduce ferredoxin, which is oxidized by the nitro group in position 5 over the nitroheterocyclic compounds such as nitazoxanide [39]. In these organisms, nitazoxanide is reduced to a toxic radical in an organelle of carbohydrate metabolism and the hydrogenosome which contains hydrogenase PFOR and ferredoxin [13, 15, 43].

After oral administration in horses, nitazoxanide is absorbed and rapidly converted to tizoxanide (deacetyl-nitazoxanide). Nitazoxanide levels are reached within 2–3 h and are not detectable 24 h after dosing, which is 99% bound to proteins and is metabolized in the liver and is excreted in urine, bile, and feces; glucuronic acid is the conjugation of the compound [39, 44].

Adverse effects are commonly reported, such as fever, anorexia, reduced appetite, lethargy, and depression (Rodríguez García et al., 2004, Delgado et al.). However, the reproductive safety of nitazoxanide has not been determined in pregnant females; it is categorized as drug B by the FDA, not used during gestation or lactation, and it has been considered that the LD 50 is 10 g/kg [11, 22, 39].

The recommended dosage for canines is 10 mg/kg every 24 h for 3 days [26]; in a study published by Cabrera and Molina, effectiveness found at 8 days of treatment was 43.75%, which increased at 30 days of treatment with 87.5% [45]. This finding differs from those found by other authors such as Moron-Soto et al. and other authors consulted [42, 46, 47], and totally contradictory with respect to human pediatric patients, where the effectiveness is 80% [48, 49].

2.7. Teclozan

In humans, one of the drugs of choice for protozoal infections is teclozan, which is a derivative of dichloroacetamide; its trade name is known as Falmonox® (Sanofi-Aventis®, Paris, France)

and its dose varies between 25 and 50 mg/kg, every 24 h, for 5 days [17]. It is a drug of high efficacy and is considered safe, since it does not present teratogenic effects and its few side effects include flatulence, nausea, meteorism, headache, rush cutaneous, and urticaria. This drug acts in the intestinal lumen being effective in treating *G. intestinalis* [28].

The mechanism of action of teclozan in humans has been described as intervening in the phospholipid metabolism preventing the formation of arachidonic acid in the parasite, which has a lethal protozoan effect and has not been determined in studies in animal species [15, 17]. This product shows an efficiency of 60% in the treatment of giardiasis in children, when oral 10 mg/kg is given every 24 h [50]. It is important to discuss that the treatment of intestinal infections caused by protozoa and treated with teclozan has shown cure rates between 80 and 93% and with very few side effects and minimal relapse.

3. Other controls for giardiasis

There are vaccines for the control of Giardiasis of Fort Dodge© Animal Health for giardia, called Giardia-Vax® for dogs and Giardia Fel-O® for cats, their effectiveness being questionable [2, 51]. It has been considered that their application according to the commercial house, should be done after 4 months of life, and repetitions every 4–6 months, which makes its use in third world countries, is not very useful, if we consider epidemiological data on the prevalence of parasites in America Latin American countries, which can reach 27%, with high prevalences such as those in Brazil and Argentina that are above 20% (prevalence). This is why the use of the Giardia-Vax® vaccine in Latin America has had little impact on the control of the disease.

In human medicine, a combination of nutritional intervention and phytotherapy is the first line of approach for the treatment of giardiasis, whereas in veterinary medicine, dietary manipulation is often combined with antiprotozoal chemotherapy. Another point to consider is the use of probiotic therapy which could be useful in preventing infection or as an adjunct to the treatment of it; in this vein, the use of commensal bacteria can determine the vulnerability and the resistance to Giardia infection in mice. The use of probiotic lactobacilli releases a low molecular weight thermosensitive factor that inhibits the proliferation of Giardia trophozoites in in vitro culture. These modern therapeutic strategies justify further investigation which could prove to be more applicable and useful than drugs for the treatment in endemic regions [8, 52].

In any case, part of the control of the agent is to improve sanitary conditions, avoid contamination of water and food with cysts of the parasite, and control of more frequent parasites in hostile environments, that is, deworming programs every 3–4 months, especially for the canine species, with effective products such as benzimidazoles and especially fenbendazole and in particular the hygiene of pets with the use of baths with detergent products based on chlorhexidine, irgasan, and benzoyl peroxide (**Table 1**).

Drug	Dose canine	Dose feline
Metronidazole	10–25 mg/kg BID for 5–8 days	15–25 mg/kg BID for 8 days
Secnidazole	30 mg/kg SID for 1–3 days	
Tinidazole	10–44 mg/kg SID for 3 days	15 mg/kg BID for 3 days
Albendazole	25 mg/kg BID for 4 days	25 mg/kg BID for 4 days
Fenbendazole	50 mg/kg SID for 3 days	50 mg/kg SID for 3 days
Febantel	37.8 mg/kg SID for 3 days	37.8 mg/kg SID for 3 days
Furazolidona	4 mg/kg BID for 7 days	4 mg/kg BID for 7 days
Quinacrina	6.6–9 mg/kg SID, BID for 5–6 days	9 mg/kg BID for 6 days
Paromomicina	125–160 mg/kg BID for 5 days	
Nitazoxanida	10 mg/kg SID for 3 days	
Teclozan	10 mg/kg SID for 3 days	

Table 1. Drugs used in canines and felines for the treatment of giardia intestinalis.

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