Efficacy of levamisole against nematode infestations in dogs

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Abstract

For endoparasitic infestations of dogs, drugs based on levamisole hydrochloride are used. That is why the purpose of the work was to conduct a field study to evaluate the effectiveness of the studied drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole-plus 10 %” against endoparasitic infestations of dogs of different breeds, ages, and sexes. According to the results of a parasitological examination of the dogs of the experimental and control groups, endoparasites established spontaneous damage, the causative agents of nematodes of the alimentary canal: species Toxocara canis with an intensity of invasion (II) from 75 to 131 EGF with an average intensity of invasion of 104.4 ± 4.85 EGF and the species Uncinaria stenocephala with an intensity of invasion from 48 to 92 EGF with an average intensity of invasion of 69.9 ± 3.71 EGF. Clinically, nematodes of the alimentary canal in dogs were manifested by poor appetite, depression state, pallor of mucous membranes, mild diarrhea, vomiting, and weight loss observed in some animals.

Based on the obtained results, it was established that the studied drug “Levamizol O.L.KAR 10 %” and the reference drug “Levamizol-plus 10 %” when deworming dogs have a pronounced nematocidal effect against endoparasites of the alimentary canal, which are caused by the following species: Toxocara canis, Toxascaris leonina, Uncinostoma stenocephala. Thus, the effectiveness of the studied drug “Levamizol O.L.KAR 10 %” for spontaneous toxocariasis infestation in dogs on the seventh day after deworming was 95 %. The reference drug “Levamizol-plus 10 %” was 91 %, and on the 14th day after deworming the animals, the effectiveness of the drugs was 100 %.

For spontaneous toxocariasis infestation in dogs, the efficacy of the studied drug “Levamizol O.L.KAR 10 %” on the seventh day after deworming was 95 %. The reference drug “Levamizol-plus 10 %” was 94.4 %, and on the 14th day after deworming the animals, the effectiveness of the drugs was 100 %. Helminthological studies have established that for spontaneous hookworm infestation in dogs on the 7th and 14th day after deworming with the study drug and the comparison drug in the recommended doses, the effectiveness of veterinary drugs was 100 %.

Field tests showed that the studied drug “Levamizol O.L.KAR 10 %” and the reference drug “Levamizol-plus 10 %” when administered once orally in the recommended doses of the manufacturer, are well tolerated by animals regardless of breed, age, sex, and body weight, not have a toxic effect on the body of animals and are effective against nematodes of the alimentary canal in dogs.

Keywords: parasitology; Toxocaroses; Uncinostomoses; dogs; levamisole; efficiency drug.

1. Introduction

Endoparasites remain the leading cause of morbidity and mortality in puppies and dogs. Ascaridosis (Toxocara canis, Toxascaris leonina) and strongylidosis (Uncinostoma stenocephala) in dogs cause significant pathology due to the migration of larvae or parasitism of young and adult nematodes in the digestive tract. Parasitological studies have established that 20–40 % of dogs and cats are infected with nematodes of the species Toxocara canis or Toxocara cati, 5–20 % of dogs are infected with hookworms (Ancylostoma and Uncinaria), and 10–30 % of dogs are infected with hairheads (Trichuris vulpis). The most common helminths are Ascaridata nematodes in dogs and cats: 10–20 % of dogs and cats are infected in urban and rural areas and approximately 60 % in kennels (Beugnet et al., 2018; Miller, 2020).

Intestinal nematodes occupy a significant place among all diseases of infectious etiology and are widespread in Ukraine among hunting, service, decorative, and stray dogs. Thus, according to the results of the examination of samples of feces from dogs, a significant spread of nematodes of the gastrointestinal tract was established (the extent of invasion was 50.18 %), the course of which was both in the form of mono invasions (35.53 %) and mixed infestations (14.65 %). During coproscopy, nematode eggs of the following

Citation:
species were most often found: *Trichuris vulpis*, *Toxocara canis*, *Ancylostoma caninum*, *Toxascaris leonina*, *Strongyloides stercoralis*. Diseases were registered in the form of mono invasions, among which trichuriosis accounted for the largest share of affected (27.11 %), toxocarosis (6.59 %), hookworm (1.83 %), and myxoinvasions. Animals from birth to 7 years were most affected. Regarding gender, females were more vulnerable. The greatest extent of infestation was among purebred dogs – 51.56 % (Saichenko & Antipov, 2020). The conducted studies established that the fauna of nematodes in the digestive tract of dogs is represented by helminths of the species *Trichuris vulpis*, *Toxocara canis*, *Toxascaris leonina* and the genus *Ancylostoma/Uncinaria*. Young dogs aged 6 to 12 months were the most infested with trichuriosis and strongyloidiasis of the digestive organs, where the extent of infestation was 32.4 and 16.8 %, respectively. For toxocarosis and toxascarosis, higher damage rates in dogs were found in puppies under six months of age – 37.0 and 16.9 %, as well as in young animals aged 6 to 12 months – 18.2 and 17.1 %, respectively. Subsequently, with the age of the dogs, the indicators of the extensiveness of the invasion gradually decreased and ranged from 2.4 to 7.5 %. Breed susceptibility of dogs to causative agents of trichuriosis, toxocarosis, toxascarosis, and strongyloidiasis of the digestive organs was characterized by a significant lesion of crossbreeds and purebred dogs, where the indicators of the extensiveness of invasion were 22.9 %, 21.5 %, 13.3 %, and 18.4 %, respectively. Dogs of hunting (22.1 %, 13.8 %, 11.7 %, and 8.2 %) and service (20.1 %, 9.7 %, 4.3 %, and 4.3 %) breeds were less infested. Less often, helmintiasis was established in dogs of decorative breeds, where the indicators of the extensiveness of the invasion ranged from 1.7 to 18.1 % (Kitichenko & Melnychuk, 2023).

The presence of dogs in urban spaces increases the risk of contamination by dog feces, which may contain soilborne helminth spores, most of which have proven zoonotic potential. Surveys of city parks and dog walking parks for the presence of helminth eggs have shown that dog feces left uncollected can cause environmental pollution. Thus, in 11.5% of the examined samples of feces, helminth eggs were found, in particular, *Toxocara canis*, *Toxascaris leonina*, *Trichuris vulpis*, hookworms of the *Ancylostomatidae* family. The most common species were hookworms from the *Ancylostomatidae* family (8 %) (Tylikowska et al., 2024). Therefore, timely diagnosis and prevention of parasitic diseases, especially in large cities, is of urgent importance, taking into account such an essential factor as environmental contamination with invasive helminth germs and the spread of anthropozoonous diseases (Raža et al., 2018; ESSCAP, 2021).

Studies of the therapeutic effectiveness of veterinary drugs and determining the level of sensitivity of helminths to them remain relevant. Providing dog owners with the necessary assortment of practical and inexpensive drugs and tools that are easy to use is the way to epizootological and epidemiological well-being in a particular region. Veterinary specialists have always been interested in the possibility of creating and using drugs that are not only more effective in the treatment and prevention of nematodes of the digestive tract in dogs but also reduce the development of drug resistance (Wiebe, 2015; Lanusse et al., 2018; Saari et al., 2018).

A representative of imidazothiazoles is levamisole hydrochloride. Levamisole is marketed worldwide in cattle, sheep, pigs, poultry, dogs, and cats against gastrointestinal and respiratory tract nematodes. Levamisole, in addition to its cholinergic effect, inhibits the activity of fumarate reductase and disrupts glycolysis and metabolism of helminths, causing their paralysis and death (Abongwa et al., 2017; Lanusse et al., 2018). Levamizole hydrochloride harms adults and larvae of nematodes but does not affect eggs and hypobiotic larvae. Levamisole does not sufficiently affect the nematode of the alimentary canal of the species *Trichuris* spp. (Lanusse et al., 2018). At the same time, levamisole is a highly effective drug that has a nematocidal effect against *Toxascaris*, *Toxascaris*, *Ancylostoma*, *Uncinaria*, *Angiostrongylus vasorum*, *Capillaria aerophila*, *Crenosoma vulpis*, *Eulatrostrongylus abstrusus*, *Ollulanus tricuspis* in dogs and cats (Bol et al., 1994; Coles & Lynn, 2014; Lanusse et al., 2018). In addition to antihelminthic action, levamisole at the molecular level has antiinflammatory, and antioxidant effects (Renoux, 1980; Chandy et al., 2016).

The manufacturer of veterinary medicines offered the preparation “Levamizole O.L.KAR 10 %” (1 ml contains 100 mg of levamisole hydrochloride) for oral use against nematodes of the alimentary canal: *Toxascaris* spp., *Toxocara* spp., *Ancylostoma* spp., *Uncinaria* spp. dogs.

The purpose of the study was clinical trials on target animals to establish the effectiveness of the study drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole plus 10 %”, which is based on levamisole hydrochloride for oral use in doses recommended by the manufacturer against nematodes of the alimentary canal in dogs.

2. Materials and methods

Dogs aged from 5 months to 6 years with a live weight of 10 to 42 kg, of various breeds and sexes, spontaneously affected by nematode pathogens of the alimentary canal: *Toxocara canis*, *Toxascaris leonina* and *Ancylostoma caninum* participated in the research. The research was conducted in veterinary clinics in Lviv, taking into account animals from the individual sector and with the participation of volunteers. Following the general rules based on clinical and parasitological studies, experimental and control groups of dogs (7 animals in each group) were formed for each type of causative agent of helminths according to the principle of analogs. For parasitic infestations, the researched drug “Levamizol O.L.KAR 10 %” was applied to the animals of the experimental groups, and the reference drug “Levamizol plus 10 %” was administered to the control groups once orally at a dose of 0.75 ml of solution per 10 kg of the animal’s body weight.

Following the assigned tasks, clinical studies of veterinary drugs were conducted on target species of animals following the principles of “Proper Clinical Practice” (VICH GL9). Determination of the effectiveness of the investigated veterinary drugs for helminthiasis of animals was carried out following the EU Guidelines – VICH GL7 “Efficacy of anthelmintics: general requirements” (VICH GL7), VICH GL19 “Efficacy of anthelmintics: specific recommendations for canines” (VICH GL19), scientific recommendations of the WAAVP on the evaluation of the effectiveness of anthelmintics for dogs and cats (Jacobs et al., 1994; Geurden et al., 2022).

Fecal samples for research were collected individually from animals, 10.0–15.0 g, in a clean plastic dish with a tight lid. Coprological studies used the sedimentation and
flotation method to determine dog helminth infestation (Zajac et al., 2021). The intensity of animal infestation by parasites was determined by counting helminth eggs in a fecal sample using McMaster's quantitative method according to M. A. Taylor’s method (Taylor et al., 2016). A saturated sodium chloride solution with a specific gravity of 1.20 (500 g of NaCl per 1.0 l of water) was used to detect nematode eggs of the alimentary canal. The number of helminth eggs in one gram of feces (EGF) was calculated using the Taylor formula (Taylor et al., 2016; Tishyn et al., 2023).

Determining the species affiliation of helminths and their embryos in dogs’ bodies was carried out microscopically using atlases of differential diagnosis (Taylor et al., 2016; Tishyn et al., 2023).

Before and after the animals’ deworming, a clinical examination of the dogs and a helminthocoprophilosophical study were conducted after 7 and 14 days. At the same time, indices of parasitological damage (extensiveness and intensity of infestation) of animals with nematodes of the alimentary canal were established before and after deworming, and the effectiveness of drugs was determined (Jacobs et al., 1994; Beugnet et al., 2022; Geurden et al., 2022). All groups of animals were observed daily.

The effectiveness of drugs against nematodes was calculated using the formula:

\[
\text{The percentage of efficacy} \, (\%) = \left[ \frac{(C - E)}{C} \right] \times 100,
\]

where \(C\) is the mean number of helminth eggs in control animals, and \(E\) is the mean number of helminth eggs in treated animals (Jacobs et al., 1994; Beugnet et al., 2022).

All procedures described in this study followed the European Directive (Directive 2010/63/ES) concerning the protection procedures of animals used for scientific purposes.

The obtained data was analyzed using Statistica 6.0 software (StatSoft Inc., USA). Data are presented in tables as \(x \pm SD\) (\(x \pm\) standard deviation). Differences between the values in control and experimental groups were determined using ANOVA (EMA/CVMP/EWP/81976/2010), where differences were considered significant at \(P < 0.05\) (with Bonferroni correction).

### 3. Results and discussion

#### 3.1. Results

During the clinical examination and parasitological examination of dogs of different breeds, ages, sexes, and body weights, which came to the veterinary clinics of Lviv with the participation of volunteers, it was found that they were affected by causative agents of nematodes of the alimentary canal: Toxocara canis, Toxascaris leonina, and Ancylostoma caninum. Clinically, nematodes of the alimentary canal in dogs were manifested by poor appetite, depressed state, pallor of mucous membranes, mild diarrhea, vomiting, and weight loss observed in some animals.

Coprophilosophical studies established that in animals, the total intensity of invasion by the pathogen Toxocara canis was from 110 to 180 eggs in one gram of feces (EGF) with an average intensity of invasion of 149.0 ± 5.62 EGF. These dogs were divided into two groups (experimental and control), seven animals each. In the experimental group of animals, the intensity of invasion by the pathogen Toxocara canis ranged from 126 to 180 eggs in one gram of feces with an average intensity of invasion of 152.9 ± 7.49 EGF. In the control group of animals, the intensity of invasion ranged from 110 to 174 eggs in one gram of feces, with an average intensity of invasion of 145.1 ± 8.71 EGF (Table 1).

After deworming the dogs of the experimental group with the drug “Levamizole O.L.KAR 10 %” and the dogs of the control group with “Levamizole plus 10 %” in the recommended doses of the manufacturer, it was established that the intensity of invasion by the causative agent Toxocara canis decreases in the animals of these groups. Thus, on the seventh day after deworming, the intensity of invasion by the pathogen Toxocara canis in the dogs of the experimental group was from 9 to 13 eggs in one gram of feces with an average intensity of invasion of 10.7 ± 0.57 EGF. In the control group, the intensity of invasion was from 10 to 16 eggs in one gram of feces, with an average intensity of invasion of 13.0 ± 0.82 EGF. On the 14th day of the experiment, after deworming the animals of the experimental group with the study drug “Levamizol O.L.KAR 10 %” and the control group with the reference drug “Levamizol-plus 10 %”, according to coprophilosophical studies, there were no eggs of the causative agent Toxocara canis (Table 1).

Thus, for spontaneous toxocariasis in dogs, the effectiveness of the studied drug “Levamizole O.L.KAR 10 %” on the seventh day after deworming was 93.0 %, and the effectiveness of the reference drug “Levamizole-plus 10 %” was 91.0 %. On the 14th day of the experiment, after deworming the animals with drugs, the effectiveness, respectively, was 100 % (Table 1).

#### Table 1

<table>
<thead>
<tr>
<th>Group of dogs</th>
<th>The amount of eggs in 1 g of feces</th>
<th>Efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before deworming</td>
<td>After deworming, day:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Research Group</td>
<td>&quot;Levamizole O.L.KAR 10 %&quot;</td>
<td>152.9 ± 7.49 (126–180)</td>
</tr>
<tr>
<td>Control group</td>
<td>&quot;Levamizole-plus 10 %&quot;</td>
<td>145.1 ± 8.71 (110–174)</td>
</tr>
</tbody>
</table>

As a result of the conducted clinical examination and parasitological examination of the dogs, general damage by the causative agent Toxascaris leonina was established with the intensity of invasion from 75 to 131 eggs in one gram of feces with an average intensity of invasion of 104.4 ± 4.85 EGF. These dogs were divided into two groups (experimental and control), seven animals each. In the experimental group of animals, the incidence of invasion by the pathogen Toxascaris leonina was 82 to 124 eggs in one gram of feces with an average intensity of invasion of 101.0 ± 5.52 EGF. In the control group of animals, the intensity of invasion by the pathogen Toxascaris leonina was from 75 to 131 eggs in
one gram of feces with an average invasion intensity of 107.7 ± 8.23 EGF (Table 2).

After deworming the dogs of the experimental group with the drug “Levamizole O.L.KAR 10 %” and the dogs of the control group with “Levamizole plus 10 %” in the recommended doses of the manufacturer, it was established that the intensity of invasion by the causative agent *Toxascaris leonina* decreases in the animals of these groups. Thus, on the seventh day after deworming the dogs of the experimental group, the intensity of invasion by the pathogen *Toxascaris leonina* was from 4 to 6 eggs in one gram of feces with an average intensity of invasion of 5.0 ± 0.31 EGF. In the control group of animals, the intensity of invasion by the pathogen *Toxascaris leonina* was from 4 to 7 eggs in one gram of feces at an average infestation intensity of 6.0 ± 0.44 EGF. On the 14th day of the experiment, after deworming the animals of the experimental group with the study drug “Levamizol O.L.KAR 10 %” and the control group with the reference drug “Levamizol-plus 10 %”, according to coprological studies, there were no eggs of the causative agent *Toxascaris leonina* (Table 2).

### Table 2

Effectiveness of the studied drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole plus 10 %” for toxascarosis infestation in dogs (x ± SD, n = 7)

<table>
<thead>
<tr>
<th>Group of dogs</th>
<th>The amount of eggs in 1 g of feces</th>
<th>Efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before deworming</td>
<td>After deworming, day:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Research Group “Levamizole O.L.KAR 10 %”</td>
<td>101.0 ± 5.52 (82–124)</td>
<td>5.0 ± 0.31 (4–6)</td>
</tr>
<tr>
<td>Control group “Levamizole-plus 10 %”</td>
<td>107.7 ± 8.23 (75–131)</td>
<td>6.0 ± 0.44 (4–7)</td>
</tr>
</tbody>
</table>

Thus, for spontaneous toxascarosis infestation in dogs, the effectiveness of the studied drug “Levamizole O.L.KAR 10 %” on the seventh day after deworming was 95.0 %, and the effectiveness of the reference drug “Levamizole-plus 10 %” was 94.4 %. On the 14th day of the experiment, after deworming the animals with drugs, the effectiveness, respectively, was 100 % (Table 2).

According to the results of the clinical examination and parasitological examination, a general lesion of the animals by the pathogen *Ancylostoma caninum* was established with an intensity of invasion from 48 to 92 eggs in one gram of feces with an average intensity of invasion of 69.9 ± 3.71 EGF. These dogs were divided into two groups (experimental and control), seven animals each. In the experimental group of animals, the intensity of invasion by the pathogen *Ancylostoma caninum* was from 56 to 92 eggs in one gram of feces with an average intensity of invasion of 72.9 ± 4.80 EGF. In the control group of animals, the intensity of invasion by the pathogen *Ancylostoma caninum* was from 48 to 87 eggs in one gram of feces at an average invasion intensity of 67.0 ± 5.82 EGF (Table 3).

After deworming the dogs of the experimental and control groups with appropriate drugs in the recommended doses, coprological studies established that no eggs of the causative agent *Ancylostoma caninum* were detected on the seventh day of the experiment. On the 14th day of the experiment, after deworming with drugs, no eggs of the causative agent *Ancylostoma caninum* were detected (Table 3).

### Table 3

Effectiveness of the studied drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole plus 10 %” for hookworm infestation in dogs (x ± SD, n = 7)

<table>
<thead>
<tr>
<th>Group of dogs (n = 7)</th>
<th>The amount of eggs in 1 g of feces</th>
<th>Efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before deworming</td>
<td>After deworming, day:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Research Group “Levamizole O.L.KAR 10 %”</td>
<td>72.9 ± 4.80 (56–92)</td>
<td>0.0</td>
</tr>
<tr>
<td>Control group “Levamizole-plus 10 %”</td>
<td>67.0 ± 5.82 (48–87)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

In general, the studied drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole-plus 10 %” showed 100% effectiveness for hookworm infestation in dogs on the 7th and 14th day after deworming.

The results of the effectiveness of the treatment of dogs aged from 5 months to 6 years, with a live weight of 10 to 42 kg, of different breeds and sexes with the study drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole-plus 10 %” for spontaneous lesions caused by causative agents of digestive nematodes of the channel: *Toxocara canis*, *Toxascaris leonine*, *Ancylostoma caninum* on the 14th day after application are shown in Table 4. In general, the results obtained from the establishment of therapeutic effectiveness indicate that the studied drug “Levamizole O.L.KAR 10 %” and the reference drug “Levamizole-plus 10 %” on the 14th day after their use in field (production) tests against toxocarosis, toxascarosis, hookworm according to the effectiveness indicators following the recommendations of the “World Association for the Advance ment of Veterinary Parasitology” (WAAVP), they can be classified as highly effective (> 98 %) nematocidal drugs.
Field tests showed that the researched drug “Levamizol O.L.KAR 10 %” and the reference drug “Levamizol-plus 10 %” when given once orally in the doses recommended by the manufacturer, are well tolerated by animals regardless of breed, age, sex, and body weight, do not has a toxic effect on the body of animals.

### Table 4

<table>
<thead>
<tr>
<th>Animals</th>
<th>Type of pathogen</th>
<th>Animal infestation and results of deworming</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before deworming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Invasion intensity, EGF</td>
</tr>
<tr>
<td>Dogs</td>
<td>Toxocara canis</td>
<td>152.9 ± 7.49 (126–180)</td>
</tr>
<tr>
<td></td>
<td>Toxascaris leonina</td>
<td>101.0 ± 5.52 (82–124)</td>
</tr>
<tr>
<td></td>
<td>Ancylostoma caninum</td>
<td>72.9 ± 4.80 (56–92)</td>
</tr>
<tr>
<td>Dogs</td>
<td>Toxocara canis</td>
<td>145.1 ± 8.71 (110–174)</td>
</tr>
<tr>
<td></td>
<td>Toxascaris leonina</td>
<td>107.7 ± 8.23 (75–131)</td>
</tr>
<tr>
<td></td>
<td>Ancylostoma caninum</td>
<td>67.0 ± 5.82 (48–87)</td>
</tr>
</tbody>
</table>

#### 3.2. Discussion

In recent decades, we have seen an increase in the global population and movement of companion animals, contributing to changes in the density and distribution of domestic parasites. There are estimated to be about 85 million domestic dogs in Europe (Carvell et al., 2020). However, it also increases the risk of animal-borne diseases, especially when many dog owners are unaware of potential threats (Do Vale et al., 2021; Tylkowska et al., 2024).

Deworming agents are the primary method of treatment and prevention against dog parasites (Coles & Lynn, 2014). Parasiticides are currently the second largest segment of the global animal health market after biologics, at €7 billion (23 % market share) (Selzer & Epe, 2021). At the same time, the sale of medicines for pets accounts for 47 % of the total share.

Levamisole is an anthelmintic used primarily for treating and controlling several nematodes in domestic animal species and is a moderate drug of choice. Levamisole can be used to treat nematode infestations of both the digestive tract and respiratory tract. The study evaluated levamisole’s effectiveness against nematodes of the digestive tract of *Toxocara canis*, *Toxascaris leonina*, and *Ancylostoma caninum* in dogs. *Toxocara* (*Toxocara canis*) is a common intestinal helminth of dogs worldwide and can infect and cause disease (migratory larva syndromes) in humans. In some countries, the prevalence of toxocariasis in puppies ranges from 51 to 100 %, and in adult dogs, up to 45 %. Epidemiological studies have shown that approximately 1.4 billion people worldwide are infected with *Toxocara* sp. (Despommier, 2003; Lee et al., 2010; Papavasilopoulos et al., 2018; Rostami et al., 2019).

In this study, dogs were infected with Toxocara canis with 110 to 180 eggs per gram of feces with an average infestation intensity of 149.0 ± 5.62 EGF. The results regarding the effectiveness of levamisole hydrochloride against toxocariasis in dogs showed that the drug “Levamizol O.L.KAR 10 %” on the seventh day after deworming the animals was 93 % effective. On the 14th day after deworming, the drug’s effectiveness was 100 %. Similar results regarding the efficacy of levamisole hydrochloride were obtained against canine toxocariasis and hookworm, the most common helminth infections. Oral administration of levamisole hydrochloride at a dose of 8 mg/kg per kilogram of body weight effectively treats gastrointestinal nematodes in dogs (Gabriel et al., 2020). Using levamisole, L-tetramizole hydrochloride (HCL) (Ketrax-ICI tablets) orally, at the rate of 15 mg per kilogram of body weight, it was established that the effectiveness of the drug against the nematode species *Toxocara canis* on the 3rd day after deworming is 94.5 %, on the 7th day – 97 %, and on the 11th and 21st day – 100 %. It was apparent that levamisole was 100 % effective against toxocariasis in dogs and did not cause harmful effects even in pregnant animals. After treatment, the general condition of the dogs gradually improved (Maqbool et al., 1998). However, in some countries, levamisole hydrochloride is prescribed for the treatment of ascariasis (*Toxocara, Toxascaris*) and hookworm (*Ancylostoma, Uncinaria*) in dogs and cats (Coles & Lynn 2014; Lanusse et al., 2018; Papich, 2021).

The causative agent of the parasitic disease *Toxascaris leonina* is less common in dogs (global prevalence in dogs was 2.9 %; from 2.2 to 3.7 %) than the species *Toxocara canis*, but it most often infects animals 3–6 months of age and older (Rostami et al., 2020). Our research showed that dogs were infected with *Toxascaris leonina* with an intensity of invasion from 75 to 131 EGF with an average intensity of invasion of 104.4 ± 4.85 EGF. Deworming of dogs with the drug “Levamizol O.L.KAR 10 %” led to removing nematodes from the digestive tract. Thus, for spontaneous toxacariasis infestation in dogs, the effectiveness of the studied drug “Levamizole O.L.KAR 10 %” on the 7th day after deworming was 95 %, and on the 14th day after deworming the animals, the effectiveness of the drug was 100 %.

Effective treatment of dogs with levamisole at a dose of 7.5 mg/kg for two days against nematodes of the *Capillaria plica* species parasitizing the urinary bladder has been proven. Endoscopic bladder control two days after this levamisole treatment and urinalysis two weeks later confirmed the
elimination of *Capillaria plica* parasites. Clinical signs disappeared within a month (Basso et al., 2014).

Hookworms (*Ancylostomatidae; Ancylostoma/Uncinaria*) are the most frequently diagnosed parasites of the digestive tract in dogs worldwide, have zoonotic potential, and are responsible for the cutaneous migration of larvae in humans (Robertson & Thompson, 2002; Mendoza-Roldan & Otranto, 2023). As a result of our clinical examination and parasitological examination of the dogs, infection with the *Ancylostoma caninum* species was established with an intensity of invasion from 48 to 92 EGF, with an average intensity of invasion of 69.9 ± 3.71 EGF. For spontaneous hookworm infestation in dogs, the effectiveness of the studied drug “Levamizol O.L.KAR 10 %” on the 7th and 14th day after deworming was 100 %.

However, levamisole hydrochloride was effective against microfilariala (microfilaricide) when administered to dogs at 10 mg/kg twice daily for 14 days. Increasing the dose every three days to 10 mg/kg twice daily and maintaining it at 10 mg/kg twice daily for the next eight days was also effective, but 5 mg/kg twice daily for 21 days was less effective, and a dose of 20 mg/kg was effective but toxic (Carlisle et al., 1984).

The effectiveness of the drug “Levamizol O.L.KAR 10 %” was not inferior to the drug “Levamizol-plus 10 %” with the active substance levamisole hydrochloride in terms of effectiveness against nematodes of the digestive tract of the species *Toxocara canis, Toxascaris leonina, Ancylostoma caninum* in dogs.

Studies have shown (Watson et al., 1988) that levamisole at a dose of 10 mg/kg of body weight when administered intravenously and orally (with and without food) to dogs affects the bioavailability of the drug. When levamisole was administered with food, the bioavailability of the drug was impaired, as absorption was slowed and possibly reduced, which in turn may affect the effectiveness of treatment against canine helminthiasis.

Summing up, despite the wide range of existing drugs for the treatment and prevention of nematode infestations of the digestive tract, the morbidity of dogs remains very significant, and the effectiveness of antiparasitic deworming is not high enough. Overall, levamisole remains a useful nematocid compound with a broad spectrum of activity and a meager cost.

**4. Conclusions**

Parasitological studies have established that the studied drug “Levamizol O.L.KAR 10 %” (solution for oral use), when used internally (orally), individually in the recommended doses with a therapeutic and preventive purpose for endoparasites of dogs caused by nematodes of the alimentary canal: *Toxocara canis, Toxascaris leonina, Ancylostoma caninum*, can be attributed, following the requirements of the “World Association for the Advancement of Veterinary Parasitology”, to a highly effective anthelmintic (efficiency > 98.0 %) and which can be recommended for use in the practice of veterinary medicine.

Field tests showed that the researched drug “Levamizol O.L.KAR 10 %” (solution for oral use) is well tolerated by animals regardless of breed, age, sex, and body weight when used once orally in the doses recommended by the manufacturer. It does not cause any side effects or changes in clinical conditions, which confirms the drug’s safety.

**Conflict of interest**

The authors declare that there is no conflict of interest.

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