

Research Article



Mono- and Mixed Invasions of Socially Dangerous *Nematodes toxocara Canis* and *Ancylostoma caninum* in Dogs in Rural and Urban Settlements in the Region North Caucasus and the Results of Tests Against them of New Drugs

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Abstract | In the constituent entities of the Russian Federation, the most common nematodes of a zoonotic nature are toxocarosis and ankylostomosis, which occur in dogs in rural and urban settlements with an EI of 70%. The aim of this work is to study nematodes in dogs in rural and urban settlements of the North Caucasus and test new drugs: tableted Helmicide F, powder Fenbental 50% and Mebentfen powder 50% for the treatment of intestinal nematodes. Studies have shown that nematodes of a zoonotic nature in dogs in the form of mono- and mixed invasions are widespread in the regions of the North Caucasus (KBR, CHR, KCHR) with a total EI of 44–68%. Associative invasion of intestinal nematodes (*Toxocara canis* and *Ancylostoma caninum*) was observed mainly in rural settlements with EI = 36.0% in urban settlements with EI = 24.0%. In the group of dogs infected with the mixed invasion of *Toxocara canis* and *Ancylostoma caninum*, the new tableted Helmicide F at a dose of 70 mg / kg of body weight had EE and IE - 100%, Fenbental 50% powder 50% at a dose of 75.0 mg / kg body weight on ADV, once had EE and IE - 100%. The new composition Mebentfen 50% powder at a dose of 70 mg / kg of live weight, once mixed with minced meat, is highly effective (EE and IE - 100%) in experiments and is recommended for the treatment and prevention of associative invasions of intestinal nematodes. *T. canis*. and *A. caninum* in dogs.

Keywords | North Caucasus, dogs; associative invasion; nematodoses, drug; new tableted Helmicide F; Fenbental powder 50%, Mebentfen powder 50% *Toxocara canis* and *Ancylostoma caninum*. extensefficiency.

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INTRODUCTION

In the constituent entities of the Russian Federation, such epidemiological threats to humans as toxocarosis, ankylostomosis, etc. are the most common nematodes of a zoonotic nature and are found in dogs with an EI of

63–90%, which requires the development of new drugs for the treatment and prevention of invasions (Humphries et al., 2013; Uspensky et al., 2014; Bittirov et al., 2018). ([//parasitesandvectors.biomedcentral.com](http://parasitesandvectors.biomedcentral.com),2019). There is information in the literature that *Toxocara canis* and *Ancylostoma caninum* infections in dogs are a global

biological threat to humanity. According to the WHO at the UN in the world, 950 million people are infected with larval toxocarosis annually, and up to 600 million people are infected with larval *Ancylostoma caninum* infection. Myositis caused by larvae *Toxocara canis* and *Ancylostoma caninum* is a serious illness for humans (Kabardiev et al., 2016; Zalikhhanov et al., 2018; Bittirov et al., 2013; Humphries et al., 2017). At the same time, the dog is the main source of these dangerous infestations. Toxocarosis and ankylostomosis infections in dogs have a very wide biogeography. The Nosological area of these zoonoses covers continental territories, i.e. countries of Africa, Europe, Asia, North America, Latin America, Australia, Oceania. In young dog populations, nematodes of zoonotic etiology (*Toxocara canis* and *Ancylostoma caninum*) have an epizootic manifestation with the formation of mixed invasions (Humphries et al., 2011; Magomedov et al., 2015), (<https://biomedres.us/fulltexts/BJSTR.MS.ID.002419>, 2019).

Purpose - to study the Nosological profile of nematodes in dogs in rural and urban settlements in the region North Caucasus and to test the effectiveness of new drugs: 1. tableted Helmicide F and 2.fenbenthal powder 50% at mixed invasion of intestinal nematodes *Toxocara canis* and *Ancylostoma caninum* in dogs (toxocarosis and ankylostomosis). 3. of Mebentfen powder 50% of associative invasions of *T. canis* and *A. caninum* in dogs.

MATERIALS AND METHODS

In 2017-2020, the prevalence of mono- and associative invasions of nematodes of a zoonotic nature in dogs in rural and urban settlements in the North Caucasus region was determined. For this, a complete helminthological autopsy was carried out on 50 corpses of dogs aged 5-12 months in rural and urban settlements according to the method of K.I. Scriabin (1928). In the first series of experiments to test the anthelmintic activity of the new tableted Helmicide F in mixed invasion of *Toxocara canis* and *Ancylostoma caninum*, 25 dogs were carried out. 2 experimental (n = 10) and 1 control (n = 5) groups of dogs were formed. Dogs of the 1st group (n = 5), infected with mixed invasion of nematodes, received a new tableted Helmicide F at a dose of 50 mg / kg of body weight with minced meat, dogs of the 2nd group (n = 10) at a dose of 70 mg / kg of body weight body once. Dogs of the 3rd group (n = 5) served as an invasive control; they did not receive a new tableted Helmicide F. According to the experimental plandays after that. With a single administration of a new tableted Helmicide F with the excrement of all dogs, copra and larvoscopy. In a second series of experiments, the effectiveness of the new powder formulation Fenbental 50% was tested for mixed invasion of *Toxocara canis* and *Ancylostoma caninum* infections also

in 25 dogs. 2 experimental (n = 10) and 1 control (n = 5) groups of dogs were formed. Dogs of the 1st group (n = 10), affected by mixed invasion of intestinal nematodes, received a new composition of Fenbental powder 50% at a dose of 60 mg / kg of live weight with minced meat, dogs of the 2nd group (n = 10) at a dose of 75 mg / kg mass, once. Dogs of the 3rd group (n = 5) served as invasive control; they did not receive the medicine. According to the experimental plan, coproscopy was performed 3, 5, 7, 10 and 15 days after a single feeding with a new composition of Fenbental 50% powder with excrement of all dogs.

In the third series of experiments, the effectiveness of the new composition of Mebentfen powder 50% was tested for mixed invasion of *Toxocara canis* and *Ancylostoma caninum* infections in 13 dogs. 2 experimental (n = 10) and 1 control (n = 3) groups of dogs were formed. Dogs of the 1st group (n = 5), affected by mixed invasion of nematodes, received a new composition» of Mebentfen powder 50% at a dose of 50 mg / kg of live weight with minced meat, dogs of the 2nd group (n = 5) at a dose of 70 mg / kg live weight, once. Dogs of the 3rd group (n = 3) served as invasive *Toxocara canis* and *Ancylostoma caninum* control; they did not receive the medicine. According to the experimental plan, coproscopy was also carried out 3, 5, 7, 10 and 15 days after a single feeding with the new composition of Mebentfen powder 50% with excrement of all dogs. The results of dog tests with the new tableted Helmicide F, the new Fenbental 50% powder and the new Mebentfen 50% powder with associative invasion *Toxocara canis* and *A. caninum* were statistically analyzed using the program Biometrics.

RESULTS AND DISCUSSION

DISTRIBUTION OF MONO-AND MIXED INVASIONS OF NEMATODOSES OF DOGS IN RURAL AND URBAN SETTLEMENTS IN THE REGION OF NORTH CAUCASUS

Intestinal nematodes dog of zoonotic etiology (*Toxocara canis* and *Ancylostoma caninum*) «...research found that in the form of mono- and mixed invasions are widespread» in rural and urban settlements in the region North Caucasus with a total EI of 68, 00% (Table 1, 2). Monoinvasion of *Toxocara canis* in dogs in rural settlements was registered with EI =18.00% and II = 173.814,5 ekz. per 1 head, ankylostomosis (*Ancylostoma caninum*), respectively, with EI – 14,00% and II - 136.211,7 ekz. per 1 head. Associative invasion caused by the nematodes *Toxocara canis* and *Ancylostoma caninum* in rural settlements was observed mainly with EI = 36,00 % with an intensity of *Toxocara canis* 138,912,6 ekz./head; *Ancylostoma caninum* 115,611,3 ekz./head (Table 1).

Table 1: Distribution of mono-and mixed invasions of zoonotic nematodes of dogs in rural settlements in the region of North Caucasus, n = 50

Indicators	Nematodes dogs of zoonotic etiology			Total investigated dogs
	Monoinvasion Toxocarosis	Monoinvasion Ankylostomosis	Mixtinvansion Toxocarosis+ Ankylostomosis	
Number of dogs examined	50			50
Invazed dogs	9	7	18	34
Extensiveness invasion (EI), %	18,00	14,00	36,00	68,00
Intensity invasion (II), ekz./ind.	173.8 14,5	136.2 11,7	138,912,6 115,611,3	-

Table 2: Distribution of mono-and mixed invasions of nematodes of dogs in urban settlements in the region of North Caucasus, n = 50

Indicators	Nematodes dogs of zoonotic etiology			Total investigated dogs
	Monoinvasion Toxocarosis	Monoinvasion Ankylostomosis	Mixtinvansion Toxocarosis+ Ankylostomosis	
Number of dogs examined	50			50
Invazed dogs	6	4	12	22
Extensiveness invasion (EI), %	12,00	8,00	24,00	44,00
Intensity invasion (II), ekz./ind.	125.4 11,7	103.6 9,8	113,210,0 86,97,5	-

EI monoinvasion of toxocarosis (*Toxocara canis*) in urban settlements in dogs was registered with =12.00% and II = 125.411,7 ekz., ankylostomosis (*Ancylostoma caninum*), respectively, with EI – 8,00% and II - 103.69,8 ekz. per 1 head. EI associative invasion caused by the nematodes in urban settlements was observed mainly with - 24,00 % with an intensity of 113,210,0; 86,97,5 ekz./head (Table 2).

At autopsy in dogs of the small intestine, the «...highest quantitative values of EI were for mixed invasions of the zoonotic nematodes, but with low values of intensity», which confirms the hypothesis of interspecific competition between childbirth *Toxocara* and *Ancylostoma*.

EFFICACY OF THE NEW OF TABLETED HELMICIDE F WITH ASSOCIATIVE INVASIONS OF ZOONOTIC ETIOLOGY TOXOCAROSIS AND ANKYLOSTOMOSIS IN DOGS

The composition of the new tableted Helmicide F in 1 g includes: albendazole - 300 mg by ADV, fenbendazole - 200 mg by ADV, cobalt chloride - 50 mg, nutrigal - 150 mg, bipolarized bentonite - 300 mg». In the first series of experiments, «...the first experimental group of dogs (n = 10) infected with a mixed invasion of a zoonotic etiology (*Toxocara canis*, *Ancylostoma caninum*) in a mixture with minced meat» was injected with a new tableted Helmicide F at a dose of 50 mg / kg body weight showed EE - 90.0% and IE - 95.5% (Table 3).

In the 2nd group of dogs (n = 10) infected with the mixed invasion of *T. canis* and *A. caninum*, the new tableted Helmicide F at a dose of 70 mg / kg body weight by ADV had EE and IE - 100%. At the same time, on the 5th day the deworming of eggs and larvae nematodes of zoonotic etiology in feces did not detect. This dosage of new tableted Helmicide F should be recognized as an effective therapeutic dose (Table 3).

Group 3 dogs (invasive control, n = 5) remained infected with intestinal nematodes of zoonotic etiology when detecting 97,98,3-98,38,6 ekz. eggs in 4-5 g feces.

Thus, the new tableted Helmicide F a dose of 70 mg /kg of body weight, mixed with minced meat, is highly effective in experiments and is recommended for the treatment and prevention of associative invasions of intestinal nematodes of zoonotic nature *Toxocara canis* and *Ancylostoma caninum* in dogs.

EFFICACY OF THE NEW COMPOSITION OF FENBENTAL POWDER 50% WITH ASSOCIATIVE INVASIONS OF ZOONOTIC ETIOLOGY TOXOCAROSIS AND ANKYLOSTOMOSIS IN DOGS

The new composition of Fenbental powder 50% in 1 g includes: fenbendazole - 250 mg by ADV, albendazole - 250 mg by ADV, cobalt chloride - 50 mg, chelate copper - 50 mg, velomin powder - 100 mg, bilogized bentonite - 300 mg.» In the second series of experiments, the first experimental group of dogs (n = 10), infected with a mixed invasion of intestinal nematodes *Toxocara canis* and *Ancylostoma*

Table 3: Efficacy of the new tableted Helmicide F by ADV with associative invasions of intestinal nematodes (*T. canis* and *A. caninum*) in dogs

Indicators	Experiment order		
	1 group dose of 50 mg / kg body weight by ADV	2 group dose of 70 mg / kg body weight by ADV	3 group invasive control
The number of infected dogs	n =10	n =10	n =5
The number of free from intestinal nematodes of dogs of zoonotic nature after treatment	9	10	0
Extensefficiency (EE), %	90,0	100	0
Number of eggs of nematodes of dogs per 4-5 g feces, ekz.			
Before prescribing experimental therapy	98,2 8,7	96,7 8,5	97,9 8,3
After prescribing experimental therapy	5,2 0,6	-	98,3 8,6
Intensefficiency (IE), %	95,5	100	0

Table 4: Efficacy of the new composition of Fenbental powder 50% by ADV with associative invasions of intestinal nematodes of zoonotic etiology (*T. canis*, *A. caninum*) in dogs

Indicators	Experiment order		
	1 group, dose of 60 mg / kg body weight by ADV	2 group, dose of 75 mg / kg body weight by ADV	3 group, invasive control
The number of infected dogs	n =10	n =10	n =5
The number of free from intestinal nematodes of dogs of zoonotic nature after treatment	9	10	0
Extensefficiency (EE), %	90,00	100	0
Number of eggs of nematodes of dogs per 4-5 g feces, ekz.			
Before prescribing experimental therapy	97,6 8,4	95,8 8,2	98,3 8,6
After prescribing experimental therapy	3,7 0,3	-	99,5 8,8
Intensefficiency (IE), %	97,6	100	0

lostoma caninum mixed with minced meat, were fed a new composition of Fenbental powder 50% at a dose of 60 mg / kg. body mass. The «...drug with a single appointment showed» EE made up- 90.0% and IE - 96.8% (Table 4).

In the 2nd group of dogs (n = 10) infected with the mixed invasion of *T. canis* and *A. caninum*, the new composition» of Fenbental powder at a dose of 75 mg kg body weight by ADV had EE and IE - 100%. At the same time, on the 5th day the deworming of eggs intestinal nematodes of zoonotic etiology in feces did not detect. This dosage of new composition of Fenbental powder 50% should be recognized as an effective therapeutic dose (Table 4). Group 3 dogs (invasive control, n = 5) remained infected with intestinal nematodes of zoonotic nature» when detecting 98,5-99,3 ekz. eggs in 4-5 g feces.

Thus, the new composition of Fenbental powder a dose of 75 mg / kg of body weight, mixed with minced meat, is highly effective in experiments and is recommended for the treatment and prevention of associative invasions of intestinal nematodes of zoonotic nature *Toxocara canis* and *Ancylostoma caninum* in dogs.

EFFICACY OF THE NEW COMPOSITION OF MEBENTFEN POWDER 50% WITH ASSOCIATIVE INVASIONS OF ZOONOTIC ETIOLOGY TOXOCAROSIS AND ANKYLOSTOMOSIS IN DOGS

The new composition of Mebentfen powder 50% in 1 g includes: mebendazole - 300 mg by ADV, fenbendazole - 200 mg by ADV, cobalt chloride - 50 mg, irrigate A, B, C, D, E, K- 50 mg, corn starch - 150 mg, bilogized bentonite - 300 mg». In the second series of experiments, the first experimental group of dogs (n = 5), infected with a mixed

Table 5: Extensefficiency (EE) of the Mebentfen powder 50% by ADV with associative invasions of intestinal nematodes of zoonotic etiology (*T. canis*, *A. caninum*) in dogs

Indicators	Experiment order		
	1 group, dose of 50 mg / kg body weight by ADV	2 group, dose of 70 mg / kg body weight by ADV	3 group, invasive control
The number of infected dogs	n =5	n =5	n =3
The number of free from nematodes of dogs of after treatment	4	5	0
Extensefficiency (EE), %	80,00	100	0

Table 6: Intensefficiency (IE) of the Mebentfen powder 50% by ADV with associative invasions of intestinal nematodes of zoonotic etiology (*T. canis*, *A. caninum*) in dogs

Indicators	Experiment order		
	1 group, dose of 50 mg / kg body weight by ADV	2 group, dose of 70 mg / kg body weight by ADV	3 group, invasive control
The number of infected dogs	n =5	n =5	n =3
Number of eggs of nematodes of dogs per 4-5 g feces, ekz.			
Before prescribing experimental therapy	94,87,6	96,37,9	95,78,1
After prescribing experimental therapy	6,20,4	-	97,48,3
Intensefficiency (IE), %	93,46	100	0

invasion of intestinal nematodes *Toxocara canis* and *Ancylostoma caninum* mixed with minced meat, were fed a new composition of Mebentfen powder 50% at a dose of 50 mg / kg. body mass. The drug with a single appointment showed EE made up- 80.00% and IE - 93.46% (Table 5, 6).

In the 2nd group of dogs (n = 10) infected with the mixed invasion of *T. canis* and *A. caninum*», the new composition of Mebentfen powder 40% at a dose of 70 mg kg body weight by ADV had EE and IE - 100%. At the same time, on the 5th day the deworming of eggs and larvae intestinal nematodes of zoonotic etiology in feces did not detect. This dosage of new composition of Mebentfen powder 50% should be recognized as an effective therapeutic dose (Table 5). Group 3 dogs (invasive control, n =3) remained infected with intestinal nematodes of zoonotic nature» when detecting 95,7-97,4 ekz. eggs in 4-5 g feces (Table 6).

Thus, the new composition of Mebentfen powder 50% a dose of 70 mg / kg of body weight, mixed with minced meat, is highly effective in experiments and is recommended for the treatment and prevention of associative invasions of intestinal nematodes of zoonotic nature *Toxocara canis* and *Ancylostoma caninum* in dogs.

For the first time, the results of studying the spread of intestinal nematodes of dogs of a zoonotic etiology (toxocarosis and ankylostomosis) in the form of mono-

and mixed invasion», as well as the effectiveness of a new tableted Helmicide F and a new composition of Fenbental powder 50% against intestinal nematodes of dogs, are presented for the first time. New data were obtained on the epizootology of toxocarosis and ankylostomosis in dogs and the therapeutic efficacy of a new tableted Helmicide F at a dose of 70 mg / kg of body weight and a new composition of Fenbental powder 50% at a dose of 75 mg / kg of body weight to combat mixed invasion of intestinal nematodes in dogs. Thus, the new composition of Mebentfen powder 50% a dose of 70 mg / kg of body weight, mixed with minced meat, is highly effective in experiments and is recommended for the treatment and prevention of associative invasions of nematodes *T. canis* and *A. caninum* in dogs. At the same time, information about the species composition of nematodes and the need to develop new methods of treatment and prevention of mixed invasions of toxocarosis and ankylostomosis in dogs agree with the opinion of many well-known authors.

CONCLUSION

Studies have shown that infections of zoonotic toxocarosis and ankylostomiasis in the form of mono- and mixed invasions are widespread in rural settlements of the North Caucasus region» with a total EI of 68.00%. Associative invasion caused by nematodes» in urban settlements was observed mainly with EI = 24.00% with an intensity of 113.2 ± 10.0; 86.9 ± 7.5 ind. eggs in 4-5 g feces. The associative invasion caused by the nematodes *Toxocara can-*

is and *Ancylostoma caninum*» was observed mainly with EI = 36.00% with an index of the abundance of invasive elements of 138.5; 114.9 specimens eggs in 4-5 g. New tableted Helmicide F at a dose of 70 mg / kg of body weight from ADV, a new composition of powder Fenbental 50% at a dose of 75 mg / kg of body weight from ADV, Mebentfen 50% powder at a dose of 70 mg / kg of body weight mixed with minced meat, once highly effective (EE and IE - 100%) in experiments and are recommended for the treatment and prevention of mono- and mixinvasions of zoonotic nematodes in dogs.

CONFLICT OF INTEREST

The authors had no conflicts in the implementation of the study, they worked according to plan. The authors declare that they have no known competing financial interests or personal relationships that could affect the work presented in this article. The co-authors of the article have no conflict of interest.

NOVELTY STATEMENT

The authors declare that the results obtained on the topic of the article were obtained empirically, and the reflected information is new for science in the field of parasitology.

AUTHORS' CONTRIBUTION

All authors took part in the study of mono- and mixed invasions of socially dangerous nematodes *Toxocara canis* and *Ancylostoma caninum* in dogs in rural and urban settlements of the North Caucasus region and the results of testing new drugs against them, took samples of feces from dogs, analyzed materials and participated in writing the manuscript. Collectively reviewed the manuscript. All authors read and approved the final version of the manuscript.

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