Disinfectants with antiparasitic effect

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Abstract. An analysis of literature sources and own research devoted to the study of disinfection properties of disinfectants based on cationic surfactants (CS), oxygen-active compounds, and halogens is presented. It has been established that the greatest disinfection activity of them is possessed by iodine complex compounds. Hydrogen peroxide is inactive against such resistant parasitic objects as ascarid eggs.

It was also established that, as a result of studying the antiparasitic properties of drugs, for each group of disinfectants, disinfectants with the most pronounced disinfection effect were determined. Of the drugs based on CS, these are "B-des" and "Brovadez-plus", of oxygen-active drugs – "Chlorine Dioxide", of chloractive drugs – "Glavchlor Extra" and "DP-2T", and of iodine-active drugs – "Povidone-iodine" and "Pharmadez".

Keywords: disinfectants, cationic surfactants, oxygenated compounds, halogens, geohelminthiasis, ovicidal effect.

Parasitic diseases are widespread in the world. According to the WHO, every fourth inhabitant of the Earth is a carrier of this or that parasite. Intestinal helminthiases are considered to be the most dangerous diseases, it is believed that they occupy the 4th place in damage to human health, in comparison with other pathologies. More than 2 billion people in the world are affected by geohelminthiases [1-3].

According to various sources, on the territory of Russia and the countries of the Near Abroad, from 60 to 70 species of helminths have been found, of which about 20-30 species are most common. In the country, 2 million patients are detected annually, however, taking into account the correction factors, the true number of them may exceed 20 million [4, 5]. Of helminthiasis, in terms of the frequency of registration among the population of Russia, enterobiasis is in the first place, and 90-95% of the patients are children. Significant circulation of the causative agent of this disease occurs in preschool, school and health care institutions. The second place is occupied by ascariasis [6-8]. The problem of toxocariasis deserves serious attention, especially in megacities. The spread of this disease is associated with an increase in the number of dogs in cities and non-observance of the rules for keeping them in the absence of measures for excrement disinfection [6-10].

The constant detection of parasitic pathogens in the environment indicates the insufficient effectiveness of disinfection measures [6, 11, 12]. In the complex of measures for disinfestation of objects of the external environment, the use of chemical agents plays an important role. However, today the range of such products is very small. Of the huge variety of disinfectants known today, only a small part is suitable for disinfestation. In addition, not all of them have such properties as a wide spectrum of action, ease of preparation, reliability of the disinfecting effect. Therefore, the search and development of new drugs with a strong antiparasitic effect remains a very important direction in the protection of the environment from contamination with invasive material and the prevention of parasitic diseases [13-17].

According to literary sources and our own research, a comparison was made of the antiparasitic activity of 28 disinfectants.

The purpose of the work is to study the physicochemical, antimicrobial, antiparasitic and disinfecting properties of various disinfecting compositions from literary sources.

1 Antiparasitic activity of disinfectants based on cationic surfactants (CS)

The most important representatives of CS are quaternary ammonium compounds (QAC), guanidine derivatives and tertiary amines. Table 1 shows the ovicidal efficacy of 6 disinfectants based on these compounds against the eggs of 8 types of helminths. Of these, 7 are representatives of the Roundworm type, suborders Ascaridata (Neoascaris vitulorum, Ascaris suum, Parascaris equorum, Ascaridia galli, Toxocara canis, Toxocara cati) and Strongylata (family Trichostrongylidae, Nematodirus sp.), and 1 – is a representative of the Flatworm type, class Cestodes (Taenia sp.). Analyzing the indicators of ovicidal action, we can say that preparations based on QAC are not very active against ascarid eggs. They show a pronounced effect in concentrations of at least 10% with prolonged exposure of 12-24 hours [2, 3]. The drug

"GABO" showed in our experiment a strong effect (ovicidal efficiency 100%) with a shorter exposure of 4 hours, but in a high concentration of 25%. On the example of the action of the drug "Aminocid" there is a noticeable difference in the sensitivity of the test objects to the action of disinfectants. This preparation, with an exposure time of 12-24 hours, was effective against Trichonema sp. (family Trichonematidae, suborder Strongylata) at a concentration of 5-10%, caused the death of eggs of Toxocara cati at a concentration of 10% and had no effect on the eggs of Taenia sp. (class Cestoda) [4].

Table 1 – Antiparasitic activity of CS-based disinfectants

Drug, composition of the drug	Test-object	Exposure time	Drug concentration	Disinfection efficiency	Source of information
Samarovka: Alkyldimethylbenzylammonium chloride; Alkyldimethylethylbenzylammonium chloride	Neoascaris vitulorum, Ascaris suum, Parascaris equorum, Ascaridia galli	24 hours	10 %	60-80 %	2
Ecosan: Alkyldimethylbenzylammonium chloride; Alkyldimethylethylbenzylammonium chloride	Toxocara canis	24 hours	10 %	60 %	3
Encke Mod: Quaternary ammonium compounds, own research	Ascaris suum	4 hours	25 %	100 %	OR
		24 hours	12 %	90 %	
Septa: Alkyldimethylbenzylammonium chloride; Didecyldimethyl ammonium chloride	Ascaris suum	4 hours	100 %	11 %	OR
		24 hours	100 %	99 %	
Aminocide: Alkyldimethylbenzylammonium chloride; N, N-bis (3aminopril) dodecylamine; Didecyldimethyl ammonium chloride	Trichonema sp.	12-24 hours	5-10 %	100 %	4
	Toxocara cati	12-24 hours	10 %	100 %	
	Taenia sp.	12-24 hours	10 %	Absent	
Brovadez: Dimethyldialkyl ammonium chloride; Didecyldimethyl ammonium chloride; EDTA	Ascaris suum	1 hour	1,5 %	92 %	6
	Trichuris suis	1 hour	1,5 %	78 %	
Bi-des:	Toxocara canis	1 hour	0,3 %	61 %	5

Dodecyldipropylene triamine; Polyhexamethylene guanidine (PGMG-x); Cocoamidopropyl Betaine (surfactant); Glutamic acid			1 %	95 %	
	Ascaris suum	1 hour	1 %	98 %	6
	Trichuris suis	1 hour	1 %	79 %	

These data indicate a relatively higher chemical sensitivity of Trichonema eggs compared to Toxocara eggs and a higher resistance of cestode eggs compared to these species. Of all the considered CS-based disinfectants, the "B-des" and "Brovadez-plus" preparations showed the highest ovicidal activity. The composition of the preparation "Bi-des" includes such representatives of CS as triamine and a guanidine derivative as the main components. In relation to eggs of a fairly stable species Toxocara canis, this drug showed a pronounced effect at a concentration of 0.3% at exposure time

1 hour [5]. It is interesting to compare the effect of the drug "Bi-des" in the same experimental conditions (1%; 1 hour) on the eggs of 3 species of nematodes. The effect of the drug on ascaridate eggs (Ascaris suum and Toxocara canis is approximately the same (the death of eggs is 98% and 95%, respectively), and the eggs of the whipworm (Trichuris suis) were more resistant (79%) [5, 6]. "Brovadez-plus" in addition to two representatives [2, 3] QAC includes EDTA, a representative of chelating agents that form strong intracomplex compounds (chelates) with metal ions. At a concentration of 1% with an exposure time of 1 hour, its ovicidal efficacy against Ascaris suum and Trichuris suis eggs was 85% and 77%, respectively [6].

2 Antiparasitic activity of disinfectants based on oxygen-active compounds

Table 2 shows data on the effect on helminth eggs of such oxygen-active compounds as hydrogen peroxide, potassium permanganate, chlorine dioxide, as well as three disinfectants based on hydrogen peroxide and other peroxide compounds.

Table 2 – Antiparasitic activity of disinfectants based on oxygen-active compounds

Drug, composition of the drug	Test-object	Exposure time	Drug concentration	Disinfection efficiency	Sourse of information
Hydrogen peroxide	Toxocara canis	60 minutes	30 %	Absent	3
		20 days	6 %	Absent	7
	Ascaris suum	4 hours	33 %	Absent	OR
		24 hours	33 %	73 %	
Peroxam Ultra: Hydrogen peroxide	Ascaris suum	24 hours	100 %	100 %	OR
			50 %	11 %	
Desolex:	Ascaris suum	24 hours	100 %	100 %	OR

Hydrogen peroxide			50 %	35 %	
Manganese-sour potassium	Toxocara canis	1 hour	30 %	Absent	3
Virkon: Potassium peroxomonosulfate; Surfactant; organic acids)	Trichonema sp.	12-24 hours	5-10 %	100%	4
	Toxocara cati	12-24 hours	10 %	100%	
	Taenia sp.	12-24 hours	10 %	Absent	
Chlorine dioxide	Ascaris suum	4 hours	0,25 %	90 %	OR
		24 hours	0,06 %	100 %	

First of all, it should be noted the low efficiency of hydrogen peroxide against helminth eggs. At a concentration of 6%, usually destructive for microbiological objects, peroxide did not affect the development of eggs of Toxocara canis at all. On the 9th day, larvae formed in them, which did not lose their viability until the end of the experiment for 20 days [7]. Even in a concentrated state (30%), hydrogen peroxide does not act on eggs of Toxocara canis at an exposure time of 1 hour [3]. In our experiments, hydrogen peroxide at a concentration of 33% did not have a detrimental effect on the eggs of Ascaris suum at an exposure time of 4 hours and showed a pronounced effect on the eggs of this object only after an exposure of 24 hours (73%). Preparations based on hydrogen peroxide "Peroxam Ultra" and "Dezolex" in undiluted form with an exposure time of 24 hours had a strong ovicidal effect on Ascaris suum eggs (OE 100%), but after dilution by 2 times their effect became weak (OE 11-35 %). The preparation "Virkon" with an exposure time of 12-24 hours was effective against eggs of Trichonema sp. at a concentration of 5-10%, against eggs of Toxocara cati - at a concentration of 10% and is ineffective against eggs of Taenia sp. at this concentration [4]. Potassium permanganate at a concentration of 40% after 1-hour exposure did not affect the further development of Toxocara canis eggs [3]. Chlorine dioxide has the strongest ovicidal effect of the considered oxygen-active compounds. In our experiments, it was active against Ascaris suum eggs at a concentration of 0.25% at an exposure time of 4 hours (90%) and caused the death of 100% of the eggs at a concentration of 0.06% at an exposure time of 24 hours.

3 Antiparasitic activity of disinfectants based on chloroactive compounds

Table 3 shows the data on the ovicidal activity of chloractive disinfectants made on the basis of sodium hypochlorite, trichloroisocyanuric acid (TCA) and sodium salt of DCCA. According to the available literature data, Toxocara canis eggs died from the action of a hypochlorite solution with an active chlorine (ACh) content of 9-16% within 30 minutes [3]. At the same time, when testing commercial drugs such as "Comet" gel ("Double effect"), "Bleach" and "Domestos", it took much longer to achieve a similar effect - from 15 to 48 hours [8]. Of all

the considered disinfectants based on sodium hypochlorite, the most active drug is "Glavkhlor Extra". As our studies have shown, from its action at a concentration of 0.45% (hereinafter, the concentration is given as active chlorine (ACh), complete elimination of Ascaris suum eggs occurred within 2 hours. Comparison of the ovicidal effect of sodium hypochlorite disinfectants suggests that it is not directly related to the ACh level in the preparations. The same conclusion can be reached by comparing the effectiveness of drugs based on isocyanuric acids and their derivatives. The ovicidal effect of disinfectants varies widely, although the reported ACh levels are approximately the same. Thus, our studies of the ovicidal activity of 4 preparations based on the sodium salt of DCCA showed the following. There is no activity of "Astera" (43% ACh content) tested at a concentration of 3% with an exposure time of 4 days against Ascaris suum eggs. In relation to the same object, the effectiveness of the drug "Pharmachlor" (ACh content 41%) at a concentration of 8% with an exposure time of 1 day was only 17%. The ovicidal efficacy of "Nika Chlor" (ACh content 45.5%) and "Nika Chlor Lux" (ACh content 42%) against Toxocara canis eggs tested at a concentration of 10% at an exposure time of 1 day was quite high and amounted to respectively, 92% and 85%. According to literary sources, the preparation "Javel Absolute" (sodium salt of TCA, content of ACh 43%) in 12-24 hours caused destruction and death of eggs of nematodes of the genus Trichonema at a concentration of 5-10%, as well as eggs of Toxocara canis and Taenia sp. - at a concentration of 10% [4]. The drug "DP-2T" based on TCA (32% ACh) is very active against the eggs of parasitic nematodes. It causes death of Toxocara canis eggs at a concentration of 5% (according to the preparation) with an exposure time of 24 hours [9], and Nematodirus sp. - at a concentration of 0.06% in 30 minutes [10].

Table 3 – Antiparasitic activity of disinfectants based on chloroactive compounds

Drug, composition of the drug	Test-object	Exposure time	Drug concentration	Disinfection efficiency	Sourse of information
Sodium hypochlorite	Toxocara canis	30 minutes	9-16 % by ACh	100 %	3
Bleach: Sodium hypochlorite; Sodium hydroxide; Surfactant	Toxocara canis invasive eggs	48 hours	4,8-14,3 % by ACh	100 %	8
Gel "Comet Double Effect": Chlorinol; Formic acid; Phosphoric acid	Toxocara canis invasive eggs	15-24 hours	100 % by drug	100 %	
Domestos: Sodium hypochlorite; Surfactant	Toxocara canis invasive eggs	48 hours	4,8 % by ACh	100 %	

Glavkhlor Extra: Sodium hypochlorite	Ascaris suum	1 hour	0,45 % by ACh	95 %	OR
		2 hours	0,45 % by ACh	100 %	
Astera: Dichloroisocyanuric acid sodium salt	Ascaris suum	4 days	3 % by ACh	Absent	OR
Farmahlor: Dichloroisocyanuric acid sodium salt	Ascaris suum	24 hours	8 % by ACh	16 %	OR
Nika Chlor: Dichloroisocyanuric acid sodium salt	Toxocara canis	23 hours	10 % by ACh	91 %	OR
Nika Chlor Lux: Dichloroisocyanuric acid sodium salt; Surfactant	Toxocara canis	23 hours	10 % by ACh	87 %	OR
Javel Absolute: Dichloroisocyanuric acid sodium salt	Trichonema sp.	12-24 hours	2- 4,3 % by ACh	100 %	4
	Toxocara cati	12-24 hours	4,3 % by ACh	100 %	
	Taenia sp.	12-24 hours	4,3 % on ACh	100 %	
DP-2T: Trichloroisocyanuric acid; Surfactant (sulfonol)	Nemato-dirus sp.	30 minutes	0,06 % by ACh	100 %	10

4 Antiparasitic activity of disinfectants based on iodine active compounds

The antiparasitic activity data shown in Table 4 indicate the high efficacy of iodine-based preparations. So the preparations "Cystodesis" and "Paradesil" containing crystalline iodine, at a concentration of 3-4%, destroy 94-100% of Buxtonella sulcata cysts within 2 hours. The drug "Paradizel" also works in relation to oocysts of Eimeria sp., And in relation to eggs of Ascaris suum, the same level of its effectiveness is achieved after exposure for 24 hours [11, 12]. The disinfection activity of disinfectants based on iodine complex compounds is even higher. The preparations "Pharmayod and" S-280 "at concentrations of 1-5% (by drug) cause the death of 100% of the eggs of such a stable object as Ascaris suum within 1-3 hours [13]. The drug "Pharmades", which includes pharmaco, is highly effective against all pathogens of parasitic diseases and is recommended as the main disinfectant for disinfecting contaminated objects [14]. In our experiments, "Pharmadez" caused the death of 100% of pork roundworm eggs at a concentration of 0.03% for active iodine (hereinafter I) within 2 hours, and within 24 hours - at a concentration of 0.002%. The drug "Povidone-iodine" was even more active. Its ovicidal

efficiency at a concentration of 0.005% according to AI with an exposure time of 2 hours was 64%, and at a concentration of 0.0006% with an exposure time of 24 hours - 100%.

Table 4 – Antiparasitic activity of disinfectants based on iodine active compounds

Drug, composition of the drug	Test-object	Exposure time	Drug concentration	Disinfection efficiency	Sourse of information
Cystodesis: Crystalline iodine; Glutaraldehyde; Ethanol%; Potassium iodide;PEG-400	Buxtonella sulcata	2 hours	3 % by drug	98 %	11
			4 % by drug	100 %	
Paradesil: Crystalline iodine; Potassium iodide; Glutaraldehyde; PEG-400; Ethanol	Ascaris suum	24 hours	3 % by drug	94 %	12
			4 % by drug	100 %	
	Buxtonella sulcata	2 hours	3 % by drug	94 %	
	Eimeria sp.	2 hours	3 % by drug	93 %	
Pharmayod: Iodophor	Ascaris suum	3 hours	1 % by drug	100 %	13
S-280: Iodophor	Ascaris suum	1 hour	5 % by drug	100 %	13
Pharmades: Pharmayod; Sodium lauryl sulfate; Syntanol;	Ascaris suum	1 hour	0,03% by DV (5% for the drug)	100%	14
		2 hours	0,03% by DV	100%	OR
			0,008% by DV	96%	
		4 hours	0,002% by DV	73%	
		24 hours	0,002% by DV	100%	
Povidone iodine: Povidone iodine; Glycerol; Nonoxynol; citric acid, etc.	Ascaris suum	2 hours	0,0005-0,005% by DV	64%	OR
		24 hours	0,0006% by DV	100%	

Conclusion

From literary sources, the disinfection properties of disinfectants based on CS, oxygen-active compounds, and halogens have been established. Complex compounds of iodine have the greatest disinfection activity of them. As a result of studying the antiparasitic properties of drugs, for each group of disinfectants, disinfectants with the most pronounced disinfection effect were determined. Of the drugs based on CS, such are "B-des" and "Brovadez-plus", of oxygen-active drugs – "Chlorine Dioxide", of chlorine-active drugs – "Glavchlor Extra" and "DP-2T", and of iodine-active drugs – "Povidone-iodine" and "Pharmades", from drugs that include aldehydes - "Cystodes-ultra", "DZPT-1" and "DZPT-2".

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