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IMPROVEMENT OF TECHNOLOGICAL STAGES IN BEEKEEPING WITH DISINFECTION MEASURES

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Disinfection is a very important technological measure, which is carried out to combat infectious diseases of bees and prevent contamination of beekeeping products with harmful microorganisms. The disinfection procedure is very complex, and its effectiveness depends on a large number of factors: the spectrum of the disinfectant, the method of application, the concentration of the disinfectant, the exposure time, and the properties of the environment to be disinfected. Active components of disinfectants usually affect the metabolism of microorganisms. For disinfection in beekeeping, we can use iodine preparations, bases, acids, quaternary ammonium compounds, oxidizers (hydrogen peroxide, peracetic acid). Effective chemical disinfectants are a warm solution of sodium hydroxide, oxidizers, so these disinfectants are most often used in beekeeping. However, the negative properties of these disinfectants should also be considered. There is no perfect disinfectant. Because of the toxicity and other harmful effects of disinfectants, and often their ineffectiveness, physical methods of disinfection should be implemented whenever possible.

The article presents the results of studies of such disinfectants as Septox, PHMG – HC and Crystal-700 in concentrations of 0.25%, 0.5%, 1.5%, as well as a comparative description of their effectiveness during "in vitro" disinfection on test objects (glass, veneer, wax) contaminated with spores of Paenibacillus larvae subsp. larvae and Ascosphaera apis. Test controls were: No. 1 – sterile physiological solution; No. 2 – Desvax (4% formaldehyde solution with 0.05% DMSO), a drug approved for disinfection of bee inventory in Ukraine (Deklaratsiinyi patent 61387A, 2003, Rudenko, 2012). The test objects were immersed in the test solutions and kept for 3, 9, 18 hours. To determine the intestinal toxicity, the test substances were fed to bees and the time and number of dead individuals were monitored.

According to the results of the sanitary and hygienic assessment of individual indicators of chemical disinfectants, the best disinfecting properties were demonstrated by 1.5% solutions of polyhexamethyleneguanidine hydrochloride, sodium hypochlorite and Crystal-700, which are environmentally safe, non-toxic, non-volatile, non-aggressive towards metals, plastics, wood, convenient to use. They can be recommended for long-term antiseptic protection, preventive, forced, current and final disinfection for bacterial, fungal and viral infections.

Key words: *technology of keeping bees, diseases, disinfection.*

УДОСКОНАЛЕННЯ ТЕХНОЛОГІЧНИХ ЕТАПІВ У БДЖІЛЬНИЦТВІ ДЕЗІНФЕКЦІЙНИМИ ЗАХОДАМИ

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Дезінфекція є дуже важливим технологічним заходом, який проводиться з метою боротьби з інфекційними захворюваннями бджіл та попередження зараження продуктів бджільництва шкідливими мікроорганізми. Процедура дезінфекції дуже складна, а її ефективність залежить від великої кількості факторів: спектру дії деззасобу, способу застосування, концентрації дезінфікуючої речовини, часу витримки, властивостей середовища, що підлягає дезінфекції. Активні компоненти дезінфікуючих засобів зазвичай впливають на метаболізм мікроорганізмів. Для дезінфекції в бджільництві можна використовувати: препарати йоду, основи, кислоти, четвертинні сполуки амонію, окислювачі (перекис водню, надоцтова кислота). Ефективними хімічними дезінфікуючими засобами є теплий розчин гідроксиду натрію, окислювачі, тому ці дезінфікуючі засоби найчастіше використовується в бджільництві. Однак негативні властивості цих дезінфікуючих засобів також слід враховувати. Ідеального дезінфікуючого засобу не існує. Через токсичність та інші шкідливі дії дезінфікуючих засобів, а часто і їх недостатню ефективність, перевагу слід віддавати фізичним методам дезінфекції, коли це можливо.

У статті наведено результати досліджень таких дезінфектантів, як Септокс, ПГМГ – ГХ та Кристал-700 у концентраціях 0,25 %, 0,5 %. 1,5 %, а також порівняльна характеристика їх ефективності за дезінфекції «in vitro» на тест–об'єктах (склі, шпоні, вощині), контамінованих спорами Paenibacillus larvae subsp. larvae та Ascosphaera apis. Контролями проведення випробувань служили: № 1 – стерильний фізіологічний розчин; № 2 – Дезвакс (4 % розчин формальдегіду з 0,05 % ДМСО), препарат, затверджений для дезінфекції бджолоінвентаря в Україні (Deklaratsiinyi patent 61387A, 2003, Rudenko, 2012). Тест-об'єкти занурювали у дослідні розчини і витримували упродовж 3, 9, 18 год.. Для визначення кишкової токсичності дослідні речовини згодовували бджолам і контролювали час та кількість загиблих особин.

За результатами санітарно-гігієнічної оцінки окремих показників хімічних дезінфікуючих засобів кращі знезаражуючі властивості проявили 1,5 %-ві розчини полігексаметіленгуанідін гидрохлориду, гіпохлориту натрію та Кристалу - 700, які є екологічно безпечними, нетоксичними, не леткими, не неагресивними відносно металів, пластмас, дерева, зручними у використанні. Вони можуть бути рекомендовані для тривалого антисептичного захисту, профілактичної, вимушеної, поточної і завершальної дезінфекції за бактерійних, грибних і вірусних інфекцій.

Ключові слова: *технологія утримання бджіл, хвороби, дезінфекція.*

Hygiene, as one of the crucial elements of beekeeping technology, is of the greatest importance for protecting the health of bees and beekeeping products (Bojanić Rašović et al. 2016).

It is known that the problem of preserving the health of honey bees is becoming increasingly acute for scientists all over the world. In particular, the level of anthropogenic load on both the bee colony and its habitat is so significant that it threatens the existence of the honey bee *Apis mellifera L* as a species (Kulhanek et al., 2017; Kovalskyi et al., 2018).

The additional negative factor against the background of anthropogenic load is the emergence, development and spread of bee diseases of various etiologies (van Engelsdorp et al., 2017). In particular, in the last decade, there has been an alarming trend of mass death of bees on a global scale, which is characterized as the collapse of the bee colony (CCD syndrome). Among the main reasons for the mass death of honey bees are infectious and invasive diseases, the use of pesticides and other chemicals in crop production, the exploitation of bees in monoculture conditions, uncontrolled industrial movements of bee colonies from one region to another (Chen et al., 2008; Guzmán-Novoa et al., 2010; Cloyd, 2019).

The situation is further complicated by the fact that the course of diseases of bees has an associated nature, parasitocenoses occur in many farms, which is connected with the widespread distribution of the *Varroa* mite in apiaries of countries around the world. A high degree of varosis damage makes for the activation of other infections and their forms, which subsequently causes difficulties in diagnosis and treatment and requires the use of a whole arsenal of therapeutic agents. Therefore, it is advisable to implement comprehensive measures to prevent diseases. (Maslii et al., 2015)

Effective combat against pathogenic microorganisms is impossible only with the help of medicines. In this regard, in recent years, many papers have highlighted the study of the possibility of increasing the resistance of families to diseases. Therefore, the study of certain elements of the hygienic behavior of insects and their use for the preservation and full development of bees in the future have become relevant. (Masliy et al., 2015, Rudenko, 2012).

Mechanical cleaning and physical and chemical methods of decontamination (disinfection) of tools and equipment used in beekeeping and, first of all, wax constructions (honeycombs) are also an important point in the elimination of infectious diseases of bees.

The important preventive work in the system of ensuring the health of honey bees is a complex of sanitary and hygienic measures, in particular, disinfection, especially of combs, because bees grow larvae, store honey and pollen. The remains of dead larvae at the bottom of the cells can store spores of the causative agents of dangerous bee diseases for a long time, and the pollen can be damaged by mold fungi.

Among the currently known disinfectants used in beekeeping and the most widely used in world practice are preparations based on formaldehyde 65%, hydrogen peroxide 20%, acetic acid 10% and lactic acid 5%. The basis of their development is the principle of universality and effective action on a wide range of pathogenic and conditionally pathogenic microflora. However, information on the safety of disinfectants both for the body of honey bees and their products, and for the environment, is quite limited and requires wider coverage and study. Among the disinfectants registered on the Ukrainian market and approved for use in beekeeping, there are only preparations based on benzalkonium chloride and sodium hypochlorite. Strong enough chemicals are approved for disinfection in beekeeping (Leshchyshyn M.V. at el., 2019).

We will describe the main ones. The oldest means is formaldehyde gas and its solution in water – formalin. Formaldehyde is colorless gas with a specific odor that irritates the mucous membranes of the eyes and nasal cavity. It dissolves easily in water, its 40% solution is called formalin. This chemical preparation has very valuable disinfecting properties, and unlike other gaseous substances such as chlorine, sulphur gas and others, does not damage the objects being processed and is less toxic. But its toxicity for service personnel is high. The main toxic active substance is formaldehyde, gas with a pungent smell. It has strong oxidizing properties and significant bactericidal properties. Furthermore, according to some authors, it has cytotoxic, hemolytic and local caustic effects.

Chlorinated lime is widely used in beekeeping. It is a dry white powder with a smell of chlorine. Upon contact with light and moisture, chlorine weathers and loses its disinfecting properties. Chlorine-containing disinfectants are known to be moderately toxic, and they are highly irritating to mucous membranes and skin.

Alkalis and acids. The most famous of the alkalis is caustic soda which is a white crystalline substance that is well soluble in water. Technical caustic soda is used for disinfection. According to research data alkalis have a strong irritating effect on the skin and mucous membranes, chronic skin lesions often occur with constant work with them. Among organic acids, formic acid and acetic acid are widely used, and from inorganic acids, hydrochloric acid is widely used. Acids have a local caustic effect (coagulation necrosis), hemato-, nephro-, and hepatotoxic effects, which are caused by hemolysis of erythrocytes, the development of toxic coagulation, and the syndrome of diffuse intravascular blood coagulation.

From the group of oxidizing agents, hydrogen peroxide is widely used. Chemically pure anhydrous, it is a clear glassy bluish liquid. Industry produces perhydrol (this is a concentrated solution containing up to 35.0% hydrogen peroxide). The preparation is stabilized, well soluble in water. But it requires careful handling when working with it, as it has a local caustic effect, is a strong oxidizer and can cause the destruction of tissues with the formation of oxygen in them (Musiienko, O.V., et al. 2019).

Therefore, taking into account the data of studies, there is a need to find highly effective, environmentally friendly and easy-to-use disinfectants with a wide spectrum of action.

The purpose of the research was a comparative study of the disinfectant properties in laboratory conditions on test objects contaminated with spores of the causative agent of American rot (*Paenibacillus larvae subsp. larvae*) and Ascosphaera apis (*Ascosphaera apis*) of polyhexamethyleneguanidine hydrochloride (PHMG-HC), a complex of benzalkonium chloride and hydrogen peroxide (Crystal-700), sodium hypochlorite (Septox), as well as determining the intestinal toxicity of these chemical compounds for bees.

Materials and methods. The following disinfectants were used for the study in concentrations:

a) Septox - 0.25%, 0.5%. 1.5%

b) PHMG - HC - 0.25%, 0.5%. 1.5%

c) Crystal-700 – 0.25%, 0.5%. 1.5%

Sodium hypochlorite is an inorganic compound, a salt of hypochloric acid of the composition NaClO, a strong oxidizer, containing 95.2% of active chlorine. It has antiseptic and disinfectant properties. It is used as a household and industrial bleach and disinfectant, a means of cleaning and disinfecting water, an oxidizer for some processes of industrial chemical production. It is used as a bactericidal and sterilizing agent in medicine, food industry and agriculture (Myers Richard L, 2007, Chyrva V. Ya. et al., 2009).

PHMG-HC has fungicidal and bactericidal properties, activity against gram-negative and gram-positive bacteria, suppresses mold, but sporicidal effect is not declared, has a long-lasting effect, maintaining a bactericidal effect from 3 days to 8 months. The bactericidal properties of the group of guanidine substances are due to the destructive electrochemical effect on the cell membrane, which plays the role of a molecular filter (Lachenmeier. Dirk W., 2015; Kovalenko V. L. et al., 2011).

"Crystal-700" is a domestic analogue of the well-known imported disinfectants

"Chemoform" (Chemoform AG, EU) and BWT BENAMIN FRESH FLÜSSIG (BWT, Austria). Benzalkonium chloride is an antiseptic drug, it also has antifungal, virucidal, and antiprotozoal effects; it is a mixture of various benzalkonium chloride compounds (Danielsen M., et al. 2008). Hydrogen peroxide is characterized by a wide spectrum of antimicrobial action, due to which it is widely used in medicine, veterinary medicine and the biological industry for disinfection. It is environmentally safe as in the environment, hydrogen peroxide quickly decomposes into water and oxygen, and the degree of biological decomposition in the soil exceeds 90%;

Disinfectant properties of chemicals were studied in vitro on test objects (glass, veneer, wax) contaminated with spores of *Paenibacillus larvae subsp. larvae* and *Ascosphaera apis*. To obtain spores, washings were made from honeycombs, in which cells with putrid mass and mummies of larvae were found. For this purpose, a sterile physiological solution (0.9% NaCl) was added to the cells of the honeycombs for (1–2) hours, which was pipetted several times to increase the output of spores. Then it was collected with sterile Pasteur pipettes into test tubes. The washings were centrifuged, the supernatant liquid was poured off, and the sediment containing spores was applied to the surface of the test objects and dried.

Test controls were: № 1 – sterile physiological solution; № 2 – Dezvax (4% formaldehyde solution with 0.05% DMSO), a preparation approved for disinfection of bee inventory in Ukraine (Deklaratsiinyi patent 61387A*, 2003, Rudenko E. V, 2012).

The test objects were immersed in the test solutions and kept for 3, 9, 18 hours. To detect viable pathogens, the test objects were washed with water after the specified time intervals. As at the beginning of the experiment, they were washed with sterile physiological solution, the supernatant liquid was drained, and the sediment was used for inoculation in Petri dishes with Willis-Hobbs nutrient medium for the causative agent of American rot and Saburo agar for the causative agent of ascospherosis. The cups were kept at room temperature and in a thermostat at 37 ºC for (72–120) hours.

To determine the intestinal toxicity for bees of test substances from the same strength of bee families (50–100) adults were taken from fifteen entomological cages, kept for several hours without food, and then experimental and control groups were formed (three cages each). The bees of the first experimental group received sugar syrup with sodium hypochlorite, the second group received PHMG-HC, the third group received Crystal-700 in the maximum experimental concentration, the fourth group (control № 1) received sugar syrup without any impurities, the fifth group received Desvax in concentration of 4%. The experimental and control groups were observed for 15 days, removing the dead every six days.

Research results. Based on the results of the research, data were obtained that indicate that the spores of the causative agent of American rot are not very sensitive to some of the experimental disinfectant solutions. The results of the research are shown in Table 1.

The obtained data indicate that sodium hypochlorite did not show disinfecting properties during minimal exposure (3 hours). In the exposition for 9 hours, its harmful effect on spores of the causative agent of American rot on glass at a concentration of 1.5 and 0.5% was observed, as well as on veneer at the maximum experimental concentration. In the case of an increase in exposure up to 18 hours, the absence of P. larvae growth was recorded on all test objects

** Deklaratsiinyi patent 61387A, (2003) Dezinfikuiuchyi rozchyn dlia obrobky bdzholiarskoho znariaddia "Dezvaks" [Disinfectant solution for treatment of beekeeping tools "Dezwax"] № 2003010512, Zaiavl. 21.01.; Opubl. 17.11.2003. Biul. № 11. 2p*

More interesting results were obtained in the PHMG–HC test. In a concentration (0.5%) after exposure for 18 hours, the death of spores was recorded on all test objects (glass, veneer, wax), and the maximum (1.5%) 100% disinfection effect was achieved on all test objects for all exposures.

Table 1

Susceptibility of spores *Paenibac. larvae subsp. larvae* to disinfectants

Name of preparation	**Concentration, %**	**Test - objects, exposure, h.**								
		glass			**veneer**			**wax**		
		3	**9**	**18**	**3**	**9**	**18**	**3**	**9**	**18**
Polyhexamethylene hydrochloride	1.5 %	–	–	–	–	–	–	–	–	–
	0.5 %	–	–	–	+	–	–	+	+	–
	0.25 %	+	–	–	+	–	–	+	+	–
Sodium hypochlorite	1.5 %	–	–	–	–	–	–	–	–	–
	0.5 %	+	–	–	+	±	–	+	+	–
	0.25 %	+	+	+	+	+	+	+	+	+
Crystal-700	1.5 %	±	–	–	±	–	–	±	–	–
	0.5 %	+	–	–	+	+	+	+	+	+
	0.25 %	+	+	+	+	+	+	+	+	+
Control No. 1 Deswax	4.0 %	–	–	–	–	–	–	–	–	–
Control No. 2 (physical solution)	0.9 %	+	+	+	+	+	+	+	+	+

Notes:
1. “–“– lack of growth of P. larvae culture on Willis-Hobbs medium
2. "+" - presence of growth of P. larvae culture on Willis-Hobbs medium
3."+" - dubious growth

As the data in Table 1 shows, Crystal-700 had a different effect on different test objects. Thus, after 18 hours of exposure, the preparation of 0.25% concentration of the working solution, did not provide disinfection of the spores of the causative agents of putrefactive diseases of bees in any of the options. The concentration of 0.5% disinfected the causative agent of rot on glass surfaces after exposure for 9 and 18 hours. The test solutions at a maximum concentration of 1.5% showed a disinfecting effect on all test objects.

Spores of the causative agent of ascospherosis turned out to be more sensitive to disinfectant solutions. The results of the research are shown in Table 2.

All tested disinfectant solutions at a concentration of 0.5% were effective. Viable spores of the causative agent of ascospherosis were not recorded in washings from glass, veneer and wax. The lowest concentration (0.25%) was not effective in any variant. Either total growth or a dubious result was observed.

Table 2

Susceptibility of *Ascosphaera apis* spores to disinfectants

Name of preparation	Concentration, %	Test - objects, exposure, h.								
		glass			veneer			wax		
		3	9	18	3	9	18	3	9	18
Polyhexamethylene hydrochloride	1.5 %	–	–	–	–	–	–	–	–	–
	0.5 %	–	–	–	–	–	–	–	–	–
	0.25 %	±	±	±	+	+	±	+	+	±
Sodium hypochlorite	1.5 %	–	–	–	–	–	–	–	–	–
	0.5 %	–	–	–	–	–	–	–	–	–
	0.25 %	+	±	±	+	±	±	+	±	±
Crystal-700	1.5 %	–	–	–	–	–	–	–	–	–
	0.5 %	–	–	–	–	–	–	–	–	–
	0.25 %	+	±	±	+	+	±	+	+	±
Control No. 1 Deswax	4.0 %	–	–	–	–	–	–	–	–	–
Control No. 2 (physical solution)	0.9 %	+	+	+	+	+	+	+	+	+

Notes:1. "–"– lack of growth of Ascosphaera apis culture on Saburo's medium
2. "+" - presence of growth of Ascosphaera apis culture on Saburo's medium
3."±" - dubious growth

Data on the study of intestinal toxicity for bees of sodium hypochlorite, polyhexamethyleneguanidine hydrochloride and the composition of Crystal-700 are shown in Table 3.

It was established that no deaths of bees were observed in any cages on the first day. On the 3rd day, the death of 2.8 ± 0.3 bees was recorded in cages of control № 2, in which Desvax was used. On the 6th day, the death of bees was recorded in cages where Crystal-700 and formalin were used.

Table 3

Study of intestinal toxicity of disinfectants for bees in cages (n=3)

Name of preparation	Concentration, %	Observation period (days), number of dead bees (individuals)					
		1	3	6	10	15	20
Polyhexamethylene hydrochloride	1.5	0	0	0	3.0±0.5	7.5±1.7	11.6±0.9
Sodium hypochlorite	1.5	0	0	0	2.3±0.2	4.4±0.3	12.0±1.5
Crystal-700	1.5	0	0	1.9±0.1	6±0.5	10.0±0.5	22.0±2.0
Control № 1 (sugar syrup)	0.25	0	0	0	0	3.5±1.2	4.8±1.4
Control № 2 Deswax	4.0	0	2.8±0.3	6.2±0.2	11.5±0.4	18.5±2.0	43.5±1.2

On the 10th day, the death of bees was already observed in all the cages where the experimental means were used and in the second positive control.

After fifteen days of observation, it was established that the death rate of bees when feeding syrup containing sodium hypochlorite was 7.5 ± 1.7, polyhexamethylene hydrochloride – 4.4 ± 0.3, Crystal-700 drug – 10.0 ± 0.5, sugar syrup – 3.5±1.2. On the twentieth day of observation, the largest number of dead bees was recorded in the cages where they were fed with the experimental product Crystal-700 (22.0±2.0). However, this indicator was two times lower than in cages where Desvax was used (43.5±1.2). In the case of using sodium hypochlorite and polyhexamethylene hydrochloride, the number of dead bees was approximately the same (11.6±0.9 and 12.0±1.5, respectively).

It should be outlined that bees took the syrup with PHMG-HC and Deswax reluctantly, and with sodium hypochlorite and sugar syrup – more actively. This is explained by the fact that table salt, which is included as a component in its composition, is necessary for bees in small quantities, and syrup is a natural food for bees. However, the concentration of sodium chlorite in this product (8.5 g per 1 liter) significantly exceeds the norm for bees. According to the veterinary and sanitary rules, the apiary must have a drip tray containing salted water at the rate of 1 g per 10 liters of water. As a result, we observed an increased death rate of bees in these experimental cages compared to the control.

Thus, disinfection in beekeeping is an important technological stage that ensures the existence and development of the industry.

Discussion. When considering a specific epizootological situation, the following should be taken into account, namely, what kind of disinfection should be carried out, preventive, forced or final. Preventive disinfection is carried out before infectious diseases appear in the apiary. Forced (focal) disinfection is aimed at destroying disease-causing agents in places of outbreaks and preventing their further spread. It is carried out during the entire period of registration of the disease (current) and is aimed at the microorganism that led to the infectious process. For providing such disinfection we tested the specified chemical substances on experimental objects infected with pathogens of rot and ascospherosis.

The final disinfection is carried out after the cessation of the disease, the purpose of which is to destroy all the remaining pathogens that were not destroyed by focal disinfection. It is carried out using the same means and the same concentration as focal disinfection (Bojanić Rašović M., 2021).

During disinfection, it is necessary to take into account the properties of microorganisms, the spectrum of action and other properties of the disinfectant, the method of application and concentration, exposure time, disinfectant medium, etc. That is why we chose glass, veneer and wax as test objects, which are most often the main environments where the pathogen resides (Maslii, I. et al., 2009).

Chemical methods of disinfection. Disinfectants are a diverse group of chemicals. For example, microbicides (bactericides, fungicides, virulicides, sporocides) kill microorganisms and their spores, while microbistatics (bacteriostatics, fungicides) only stop the growth of microorganisms (Buchrieser and Miorini, 2009).

Disinfectant solution should be prepared immediately before use, as its effectiveness decreases over time. Disinfection of surfaces and objects can be carried out by immersing in a disinfectant, wiping with a cloth soaked in disinfectant. solution, spraying the solution in the air, evaporating it. In our research, we chose the immersion method.

One of the most promising are guanidine derivatives, which combine reliable disinfectant properties with relatively low toxicity. Among these derivatives, polyhexamethyleneguanidine (PHMG) and its salts with acids, in particular hydrochlorides, are the most well-known. Due to the presence of various functional groups, they have increased adhesion to surfaces of various structures, thus ensuring longevity. Precisely because these substances are safe and used in the food industry, as well as for water disinfection, we chose them for testing in beekeeping (Maslii I. et al., 2009).

Chemical methods of disinfection in many ways dominate over physical methods. Before disinfection, it is necessary to carry out preliminary mechanical cleaning and sanitary washing, and then the disinfection itself. In addition to these, other physical methods also deserve attention. They are mainly based on the application of dry or moist heat and radiation. Burning or using a blowtorch flame is the oldest and most effective method of physical disinfection. In this case, very resistant bacteria (such as the causative agent of American rot of bee brood), especially in spore form, are destroyed. We can disinfect metal and some wooden objects in this way.

Ultraviolet radiation with a wavelength of 253–280 nm has a bactericidal effect. Maximum efficiency is achieved by rays with a wavelength of 265 nm. Sources of UV radiation, in addition to the sun, can be various fluorescent lamps. Ultraviolet radiation cannot penetrate inside the treated objects, but acts only on the surface. Spore-forming bacteria are resistant to ultraviolet radiation (Titera, 2009). In our own research, we have confirmed that the effectiveness of the bactericidal action of UV radiation is influenced by the wavelength, intensity of irradiation, duration of exposure, species belonging to the treated microorganisms, and distance from the source. It is extremely difficult to take into account all these parameters so that it is possible to have a one-time effect on the entire spectrum of microorganisms. In previous experiments, we established that UV radiation is highly active if microorganisms are located on the surface of the objects being processed in one layer. With a multilayer arrangement, the phenomenon of shielding is observed, when the upper layers protect those below them (Romanchenko M. A. Maslii I. H. et al., 2015).

Conclusions and prospects for further research. Thus, the sanitary and hygienic assessment of individual indicators of chemical disinfectants indicates the best disinfecting properties of 1.5% solutions of polyhexamethyleneguanidine hydrochloride, sodium hypochlorite and Crystal -700, which are environmentally safe, non-toxic, non-volatile, non-aggressive towards metals, plastics, wood, convenient to use. These means can be recommended for long-term antiseptic protection, preventive, forced, current and final disinfection for bacterial, fungal and viral infections.

However, due to the fact that Crystal-700 is not produced we consider it expedient to test PHMG-HC in beekeeping in productive apiaries.

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