Influence of ultralow of ETAPHOS preparation on Daphnia magna Straus and microalgae Scenedesmus quadricauda test organisms

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I. Introduction

Research of mechanisms of management in biosystems by means of chemical agents is one of the most acute problems of contemporary biology and biophysics. Under the influence of the chemical agent on biosystem, its condition or behaviour changes [1]. It is known that nanoparticles are able to cause a wide scope of cell-mediated responses depending on their characteristics, concentration and interrelation with biological molecules [2]. Based on connections between characteristics of nanoscaled materials and their potential toxic effect, a group of researchers affirms that harmful properties of nanoparticles can be changed, at that preserving catalytically valuable functions for industrial use [3, 4].

Most often the stimulation caused by the fact that addition is a biogenic element. The main factor is biologically active substances of different groups affecting to the physiological activity. Accumulated to date experimental data evidence that aqueous systems containing solutes of different nature in low (including picomolar) and ultra low (femtomolar or lower) concentrations have a number of special properties. For instance, it is found that there are non-monotonic biological effects depending on the concentration of biologically active substances (BAS) solutions at low concentrations down to 1.10 -25 mol / l [5, 6, 7]. Non-monotonic concentration dependences of biological effects in BAS low concentrations is the most important and interesting feature of the "effect of ultra-low concentrations".

In some cases, [8] dependence is bimodal: the effect increases with ultra low concentration of the preparation, then reaches a maximum and thereafter as the dose is reduced, replaced by a "dead zone" and then again increases. Sometimes we can observe the stage of "sign change" effect in dose dependence. Thus, as the concentration increases, the inhibitory activity in the field of ultra-low doses changes to the stimulating activity and then inhibitory effect reappears.

In the case of sufficiently representative dilution series there is not only a bimodal, but even wavy "dose-effect" dependence, which apply the term "hormesis" ("change of sign effect" during the transition from normal concentrations to the field of low and ultra low concentrations) [9].

The aim of this work is studying of influence of ultralow of synthesized preparation ETAPHOS on Daphnia magna Straus and microalgae Scenedesmus quadricauda test-organisms.

For execution of the assigned aim the following tasks were solved:

1. To evaluate toxic level of investigated substances on the grounds of death rate of Daphnia magna Straus test-object.

2. To reveal stimulating effect of examined concentrations on population of test-objects according to biomass yield.

Material and methods. For research of ETAPHOS preparation in a concentration range of an aqueous solution of 10^{-19} to 10^{-5} mg/l with deionized water which was oxygenized with the help of aqua-aerator and cultivated water. Definition of toxicity of substance under examination was held in accordance with requirements of Federal environment protection regulatory document 16.1:2.3.3.9-06[10] and FR.1.39.2001.00284[11]. Test-objects biomass yield was executed according to the method [12].

Biological objects of water ecosystem biocenosis Daphnia magna Straus and microalgae Scenedesmus quadricauda were chosen as test-organisms for detection of toxic level of surrounding environment components. It is known that microalgae Scenedesmus quadricauda is a component of biological sludge taking part in cleansing of waste water. Bacterial composition of active sludge is stable for a long period of operation. The dominant genera are Pseudomonas and Alcaligenes (5-39 and 36-84% respectively), whereas Bacillus, Zoogloea and facultative anaerobes are indicators of purification process disturbance [13].

It is also evident that the change in the number of protozoa depends on the loading on the active sludge. There are so-called indicator organisms in the active sludge and their condition show the normal flow of the cleaning process. They include infusoriums - Ciliata, Paramecium, Lacrimaria, Stentor, Stilonichia, Euplofes patella, Aspidisca costata, Opercularia, Vorticella. It is found that in normal developed biocenosis 1016 bacterial cells have 10-16 cell protozoa, in sludge of lower quality - 5-9 cells, and in abnormally working cleaning systems - 1-4 cells [13].

In systems with changing loading to the active sludge in the course of the fluid motion (aeration propellants, biofilters) the composition of microflora changes. Heterotrophic bacteria and protozoa that feed with the dissolved components of wastewater mainly develop in the biocenosis at the initial stage of the cleaning process, when per unit of biomass accounts larger part of the substrate. Further, with the reduction of water pollution the number of bacteria reduces, and more freely floating protozoa that feed bacteria appear. At the end of the cleaning process a large amount of predatory protozoa is developing and lower invertebrates is occuring [13].

According to literature data [13], deep biological purification of waste water is performed with the help of microalgae culture. Positive effect of microalgae cultivation consists not only in decrease of nitrogen and phosphor concentration in purified water but also in its antiseptic activity.

Cultivated water (sample - 1) and deionized water – sample -2 served as control samples in the experiment.

II. Results and their discussion

During the researches it was assessed the toxicity of Etafos preparation in a concentration range of an aqueous solution of 10^{-19} to 10^{-5} mg/l.

Data received concerning acute toxicity of the studied compound is given in figure 1.

As it is obvious from the data of figure 1, acute toxicity of ETAPHOS was observed in solutions with concentrations of 10^{-5}, 10^{-6} and 10^{-8} mg/l, in which 50% of death rate of objects happened during 48 hours from the beginning of the experiment. In solutions with concentrations of 10^{-7}, 10^{-11}, 10^{-12}, 10^{-14} mg/l and from 10^{-17} mg/l chronic toxicity is detected.

During study of chronic toxicity increase of population quantity of test-objects concentrations of 10^{-9}, 10^{-10} and 10^{-19} mg/l is detected after 56 hours from the beginning of the experiment.

Data concerning biomass yield of test-objects received during the experiment (240 hours) are presented in figures 2 and 3.

According to the picture 2 the highest fecundity of Daphnias and microalgaes' intensive growth were observed in the bulb with 10^{-9} concentration.

The lowest biomass yield (2 mg) is detected in solutions with 10^{-14} and 10^{-18} mg/l concentrations and that is 5 times smaller than in sample 1.

Conclusion

It is stated that bio-effect of ETAPHOS preparation demonstrates itself diametrically opposite depending on its content concerning minute and ultralow concentrations. More specifically while diluting the solution from concentration of 10^{-5} to 10^{-19} mg/l alternation of toxicity and stimulating activity of one and the same preparation towards researched test-objects is revealed.

Uniqueness of acquired results consists in the fact that preparation under study can be used both as growth inhibitor of certain biological objects and as stimulator depending on absolute value of super small content of substance influencing on biological object in the solution.

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