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Tetiana I. Bilyk, Candidate of Biology, assoc. Prof.
Olga S. Shtyka, student
Anastasia O. Avdeyeva, student
Anastasia O. Padalka, student

BIOAVAILABILITY OF POLLUTANTS IN WATER AND SOIL ENVIRONMENTS

The problem of xenobiotics bioavailability in soil and water medium is currently the object of considerable attention of scientists, environment activists, and policy makers. The concept of xenobiotics bioavailability is seldom defined precisely. Every branch of science explains it in its own way. In present publication we are trying to reveal the idea of bioavailability concept and to connect bioavailability definitions to the concept of water and soil system pollution.

Розглянуто проблему біодоступності ксенобіотиків у ґрунті і водному середовищі, якій приділяється багато уваги вчених, захисників природи та політиків. Концепція біодоступності має декілька підходів - кожна наукова галузь має своє пояснення терміну. Наведено принцип та механізм біодоступності. Визначено зв'язок між рівнем забруднення водного середовища і ґрунту та біодоступністю ксенобіотиків у них.

Introduction

Chemical pollution of water and soil environment can be defined as accumulation of anthropogenic origin of chemical compounds and elements in amounts that are able to cause damage to living organisms. There is supposition according to which accumulated xenobiotics can not always migrate and penetrate to living organisms and not all organisms are able to uptake pollutants. This concept is called bioavailability of xenobiotics.

Nowadays this supposition is widely studied by scientists, environment activists etc. because it may be important within a process of pollution danger level assessment.

Analysis of researchers and publications

Precise studying of bioavailability began in the 70-s of in the last century primary by physical chemists and biologists. Today this phenomenon is found to be interesting for scientists connected with environment protection, because it defines conditions of chemical pollutants penetration into the living organisms.

Today a big attention for studing of this problem is paid in the USA (Cornell University: Laboratory of Environment Geophysics, Comparative and Environmental Toxicology) and France (Vandoeuvre les Nancy).

Purpose

The purpose of the publication is to reveal the notion of bioavailability according to different points of view, to define peculiarities of this phenomenon in the water and soil environments, to detect the main composers of this process (Dickson). The practical part is to assess bioavailability of oil products.

General concept of xenobiotics bioavailability in soil and water environments

Today many technological processes cause considerable contamination of water and soil environments, especially dangerous elements and compounds that are widely used, existing in low nature concentrations [1]. In this context bioavailability is substantial for assessment of contamination danger level and forecasting changes in ecosystems.

Firstly the concept of biological availability was suggested in 1975 at a National Science Foundation workshop on ecosystem processes and organic pollutions. Primary it was grounded mainly on the physical chemistry [2; 3].

Since then the concept of bioavailability began its development independently by biologists and chemists. The latters have determined bioavailability in term of the chemical form in what element or compound of interest occurs at a given time [2]. Biologists supposed that the chemical form in the bulk phase could be relevant to existing of certain receptor that had biological nature. Thus, it was assumed that bioavailability, grounded on a portion of matter, was able to penetrate into an organism under a certain set of conditions.

Primary bioavailability was studied in a context of plants nutrition and was explained as a "processes of supplying nutrients to biological organisms" [3].

The common ground is a suggestion that in the immediate mediums of organism, there is a control volume, determined as a volume that effectively influences on certain chemicals "consumption" by the living organism, independently on being nutrient or xenobiotic.

More efficient definition of bioavailability may be considered that is proposed by Dickson. In accordance of with author's persuasions, bioavailability concept includes three components such as environmental availability, environmental and toxicological bioavailability.

The notion environmental availability of xenobiotics in both soil and water mediums may be assumed as a certain "portion of total material presence in a compartments of the environment that actually participates in a particular process or group of processes and is a subject to modify its influence [2]. In both mediums main parameters that define environmental availability are form, concentration, compartments, time. Thus these components represent common potentially available to living organism components amount.

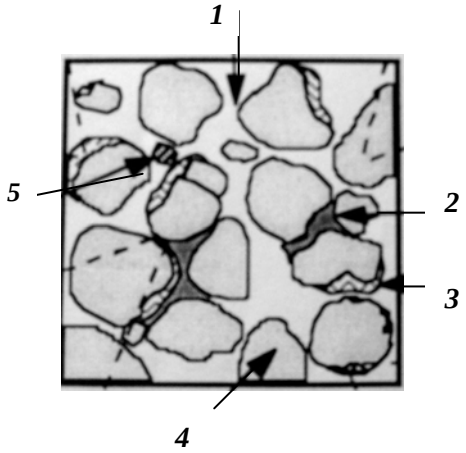
Environment bioavailability is explained as a portion of total amount of chemical compounds of elements in the organisms' exposure environment that are considered to be accessible for absorption. The major parameter of the environmental bioavailability are encounter, rate and efficiency.

Toxicological bioavailability was proposed as the third composer of general notion bioavailability it means the portion or doze that is absorbed by living organism that reaches the target side (organ or system) or effect intercellular concentration inside organism (like blood). The doze at target site is the considerable parameter of toxicological bioavailability [4].

While determining bioavailability of chemical pollutants in soil systems it is important to take into account the peculiarities of the soil system that can be defined the environmental bioavailability rate [5]. The main parameters are granulometrical composition of soil (the more heavy mechanical composition is the more ability to keep pollutants), anion content and level of acidity that impact on appearing of mobile forms of contaminators [6] (as an example cadmium migrates and penetrates into plant easily if pH level of soil medium is equal to 4.5-5.5). Surplus of moisture in soil accomplish appearing contaminators in low oxidation stage and in more soluble forms, in this way effecting on bioavailability of substances. Especial parameter is considered to be humus content. As an example with heavy metals, their bioavailability in soil medium increases in a case of high level of humus contain. Metal-toxicants combined in the complex compounds with organic matter of soils, beginning unavailable for plant absorption.

In the water medium environment bioavailability depends on the form and sizes of the chemical contaminator, anion and cation water content [5].

The figure represents the process of geosorbents keeping of different forms of substances.



Concpetual model of pollutants keeping:
1 is water or gas in macropores;
2 is nonaqueous phase liquid (NAPL);
3 is sorbent organic matter;
4 is geosorbent;
5 is pollutant as an example combustion residue, e.g. shoot etc

In this case it is shown catching of organic matte, combustion residue particulate carbon, and anthropogenic carbon including nonaqueous phase liquid (NAPL).

Bioavailability assessment

Within this work the impact of oil products such as aviation petrol (mark Б-95) and diesel fuel (mark "Litnye") on hydrobionts was estimated. Estimation of toxic properties of chemical compounds and water medium with using biotesting are widely applied in hydroecology.

Biotesting method is accomplished in defining of changes in surviving of test-objects as a consequence of negative factor influence in comparison with control measurement. The toxic criteria is death of 50% and more of investigated biotest objects within a certain period of time. As an example, there is short-time test, duration of which is equal to from 24 till 96 hours and that let have possibility to appreciate acute toxic action on tested object.

In laboratory condition investigations were fulfilled, using biological testing objects Poecillia reticulata Peters (fish) and Daphnia magna Straus (invertebrates) [7; 8; 9].

Analyzing obtained results from distinguished oil products toxicity of biotests, it is necessary to admit aviation fuel to manifest bigger level of toxicity.

Defining toxicity of diesel and aviation fuel toxicity for objects Poecillia reticulata Peters, the dependence between toxicants concentration and mortality was not noticed (table).

Results of investigation

State of acting	Aviation petrol, ml/l		Diesel fuel, ml/l	
	LC^{48}_{0}	LC^{48}_{50}	LC^{48}_{0}	LC^{48}_{50}
Emulsion	0.001	0.01	0.03	0.07
Settled emulsion	0.03	0.04	0.01	0.08
Settled emulsion without surface film	0.09	>0.25	>0.25	>0.25

The difference between the acute action of oil products in investigations on invertebrates and fish can be explained by some reasons. First of all, fish gills apparatus differs from invertebrate one. Comparing their apparatus morphological structures invertebrates have resembling "filters", that's why emulgated particles of oil products did not cause great damage in the water medium. This phenomenon is closely connected with the term "xenobiotics bioavailability". In this case, it is defined as the level of biotests surviving. The second reason is that fish can be characterized by active way of movement in the water environment annoying phase of differentiation water –oil products [10].

With regard to the term bioavailability it is important not to put equal sign between toxicity to one or other species, assimilation and bioavailability. A compound may be uptaken, being toxic, do not stimulate damage because it is relocated no in the tissue, intercellular space or cell where toxicity may be expressed. Certain compound can be uptaken into cells, not being biodegraded as a consequence of requisite catabolic enzyme failure. The process of assimilation is one for bioavailability appreciation [2] .

The key aspect of experimental data mentioned in the preceding subsections is the fact that they all manifact the relativity of the concept of bioavailability, whichever way it is measured. Under these conditions, any attempt to predict the bioavailability of a certain xenobiotics to any organism, based on experiment data involving other organism or even slightly different experimental conditions should be approached with great caution.

To become "available" to a target organism, xenobiotics in surface environments have to satisfy at least one of conditions. They have to be able to migrate themselves to the immediate vicinity of the organism. In the experiments usage of different forms oil products (emulsion, settled emultion, settled emulsion without surface film) cause various toxic effect for hydrobionts as a result of bioabaliability of these forms of organic pollutants.

The mentioned above experiment depicts that a substance can have different degree of availability that should be taken into consideration making practical decisions connected with toxic substances because the degree of availability of toxicant determines significantly impacts on the environment.

Conclusion

Problem of bioavailability is discussed by the scientists all over the world to explain various toxicity of substance being in different states in the environment, and on which depends its toxicity.

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