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BEHAVIOR AND BIOLOGICAL TRANSFORMATION OF ENVIRONMENTAL TOXICANTS IN THE ENVIRONMENT

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Abstract: *This paper examines the behavior of environmental toxicants in the environment and their biological transformation. Organic and inorganic environmental toxicants undergo hydrolysis, reduction, oxidation, photoisomerization, photoionization, photomineralization, etc. reactions, either spontaneously or under the influence, primarily of microorganisms, but also of plants and animals.*

Key words: *ecology, environment, microorganisms, toxicants.*

INTRODUCTION

The basis of the processes that condition the current state of the biosphere are the processes of chemical and micro (biological) transformation of toxic substances, by which man constantly pollutes the environment (Ložničenko et al., 2008). To solve various environmental problems imposed by the modern state of the environment, it is very important to apply precise methods of chemical analysis as well as other methods of bioindication and biotesting of various objects from the environment - air, soil, water and living organisms (Põllumaa et al., 2004; Kuczyńska et al., 2005; Đukić et al. , 2013). Thanks to that, it is possible to monitor and direct the mechanisms of chemical and biological transformation of certain compounds or groups of compounds in the conditions of action of natural and anthropogenic factors.

The aim of this informative review paper is to point out the behavior of environmental toxicants in the environment and possible pathways of its chemical and especially biological transformation.

Behavior of environmental toxicants in the environment

Upon arrival in the environment, heavy metals undergo various transformations with a change in valence and solubility. Metallurgical companies release heavy metals, mostly in insoluble form. However, during atmospheric transfer, they are extracted in the form of aerosol particles and converted into ionic, water-soluble form. o is conditioned by the presence of ionic acids (HNO_3, H_2SO_4) in the atmosphere. The intensity of extraction is evidenced by the fact that the Antarctic aerosol contains metals exclusively in water-soluble form.

Ecological toxicants of organic nature undergo the following basic transformations: hydrolysis, reduction, oxidation, photoisomerization, photoionization, photomineralization, etc.

Hydrolysis involves the saponification of complex ethers and the replacement of halogen atoms with a hydroxyl group. A typical example of the hydrolytic replacement of chlorine atoms with the -OH group is with pesticides with chlorine. The rate of their hydrolysis depends significantly on soil pH and temperature. In acidic soils with low temperatures, organochlorine pesticides are retained for several years.

Reduction processes in the environment usually take place in an anaerobic environment, for example in sediments. As a result of the life activity of some, where oxygen is released, the reduction of Fe (III) to Fe(II) and some other processes.

Oxidation of chemical substances in the gaseous and aqueous phases, and also in the adsorbed state, occurs primarily at the expense of various activated forms of oxygen. Chemical reactions with the participation of (singlet) excited oxygen are conditioned by the electronic structure of its molecule: the existence of an unfilled π-orbital determines its electrophilic character, due to which singlet oxygen enters reactions with unsaturated compounds, e.g. -position. Concentrations of singlet oxygen in the atmosphere are at the level of 108 cm^3, and in aquatic environments 10-12 cm^3, and such small concentrations still do not allow for a detailed analysis of their role in the ecosystem.

In the upper layers of the atmosphere during the photodissociation of oxygen molecules, and in the troposphere into which light with wavelengths below 290 nm does not penetrate, atomic oxygen is created during the photodissociation of nitrogen dioxide. It can be combined with double alkene bonds. In reactions with alkenes, another active form of oxygen competes - ozone, whose concentration in ground air is at the level of 1012-1013 cm^3. The reaction of alkenes, for example, chlordiene, with ozone has several phases. As a result of the first of them, ozonide is formed, further decomposition with the termination of the O-O bond leads to the formation of reactive radicals.

The return from the excited to the ground state, when light is absorbed by molecules, can take place in several ways: at the expense of photoisomerization, photoionization, energy transfer to another molecule, which is then chemically transformed, and photomineralization, which is the complete decomposition of chemicals into simple inorganic molecules (CO_2, H_2O, HCl). In the aqueous and gaseous phase, organochlorine pesticides are relatively resistant, adsorbing on the surface of silicate materials, they are quickly mineralized.

Biological transformation of environmental toxicants in the environment

Inorganic environmental toxicants. Many organisms possess natural mechanisms for metabolizing and removing heavy metals, most commonly in the form of organic heavy metal compounds (Bentley, Chasteen, 2002). One of the mechanisms of biomethylation is the transfer of the methyl group from the modified form B12. As donors, the methyl group also serves as products of N-methyl-tetra-hydrofolate and S-adenosylmethionine.

The process of biological methylation is most intensively performed by microorganisms (bacteria similar to pseudomonas), which live in sedimentary rocks. Therefore, organometallic compounds, in the largest quantities, enter aquatic ecosystems.

Due to the rather high chemical stability and lipophilicity, organic forms of mercury and some other heavy metals accumulate in adipose tissue and are transmitted through food chains.

Mechanism of organic environmental toxicants. Enzymatic reactions can lead to the detoxification of environmental toxicants, as well as to the formation of metabolites with higher toxicity, so in the latter case we are talking about activation. Three types of enzyme-induced transformation are possible: complete mineralization and degradation of xenobiotics to low molecular weight compounds, which are then released into the environment and incorporated into the natural environments of matter; chemical transformation with accumulation of metabolites in the cells of organisms.

Nonspecific enzymatic transformations. Living organisms, with the exception of some other bacteria, do not possess specific enzymes for the transformation of xenobiotics. Nonspecific enzymatic transformations usually involve oxidation, reduction, and hydrolysis reactions (Parkinson, 2001). Oxidation processes are the most common. A typical example of oxidative metabolism is the oxidation of alcohol ethanol followed by aldehyde dehydrogenases ($CH_3CH_2OH \rightarrow CH_3CHO \rightarrow CH_3COOH$). Reduction processes in organisms have been less studied than oxidative ones. An example of a reduction transformation is the reduction of disulfide. In plant tissues, nitroso compounds are probably reduced by nitro- and azoreductases to amines.

Hydrolysis reactions include, above all, the breakdown of starch, proteins and neutral fats. These reactions are catalyzed by hydrolase enzymes (enzymes that break down fat-type complex ethers called esterases). Among the means for chemical protection of plants from insects, there are many substances with complex ether groups, especially interorganophosphorous compounds. This is explained by the fact that in insect organisms, unlike mammalian organisms, the set of esterases is poor, which is why insects do not detoxify rapidly, but accumulate to a lethal concentration.

Conjugation. In plants that do not have excretory systems, analogous to the excretory organs in animals, there is usually conjugation of xenobiotics (or their metabolites) with carbohydrates and deposition in fats that are not related to the basic metabolism (Parkinson, 2001).

An important stage of biological transformation in vertebrates is the conversion of hydrophobic compounds into water-soluble ones, which cannot be excreted in the urine. The previous stage of transformation of a hydrophobic xenobiotic must be the introduction into the molecules of a polar group, for example its C-hydroxylation. Further, conjugation-binding of xenobiotics or products of their transformation with hydrophilic molecules, such as sulfate ion and glucuronic acid, takes place. These molecules are present in biological environments in small concentrations.

The summary process of C-hydroxylation and conjugation with sulfate ion is given for the benzene molecule:

$$C_6H_6 = C_6H_5OH = C_6H_5OSO_3K + H_2O$$

Finally, toxic benzene is removed from organisms with urine in the form of caligum salt of phenol sulfoether.

Unfortunately, no attention is paid to biological bodies and processes in the curricula. Not only specialists or agronomists must have knowledge about them, but literally every person, because the ecological security in any region (area) is closely connected with humic substances, and the stability of land and water areas, soil and biocenoses depends on them. Knowledge of such processes and bodies must be significantly reconciled.

CONCLUSION

The human impact on the environment has reached worrying proportions. In order to radically improve the state of the environment, it is necessary to introduce very well-thought-out and focused activities. Responsible and effective policy in relation to the environment will be possible only if we collect comprehensive data on the current (current) state of the environment, apply knowledge about the interaction of important environmental factors and develop new methods that will reduce and even prevent human damage. inflicts on nature, counting on the possibility of living systems, especially microorganisms, to play the most important role in it.

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