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ENGLISH VERSION: THE TYPICAL PATHOCHEMICAL REACTIONS OF THE DAMAGING IMPACT OF DETERGENTS AS SOURCES OF RADIOTOXINS*

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The mechanism of biological impact of detergents to the organisms of laboratory animals was researched. The detergents have properties of surface active agents and stimulate the reactions of free radical oxidation of lipids. This causes to the accumulation of peroxides, hydroperoxides and free radicals, diene conjugates, malonic dialdehyde. At the same time, propionic and acetic aldehyde, acetone, alcohols and other low-molecular-weight metabolites are formed by microsomal oxidation of the detergents. All these products are emitters of radiotoxins. The accumulation of peroxides, hydroperoxides and free radicals, malonic, acetic, propionic aldehydes, acetone, alcohol leads to depletion of the antioxidant system, i.e. the concentrations of SH - group, glutathione, vitamin C, haptoglobin, epinephrine, norepinephrine, microelements Fe²⁺, Cu²⁺, Mg²⁺ are reduced in the organs of the animals. The activity of catalase, peroxidase, glutathione peroxidase, lactate dehydrogenase, monoamine oxidase, ceruloplasmin, Ca²⁺, Mg²⁺ -ATPase is decreased in organisms of experimental animals are treated by surface active agents for a long time. Activity of marker enzymes of cytoplasmic membranes – Na⁺, K⁺ - ATPase, adenylate cyclase is decreased by disturbance of membrane structure, quantitative and qualitative changes of characteristics of the phospholipid layer. Radiomimetic action of the detergents such as stimulation of free radical pathology in the organism is a conceptual model of the mechanism of their biological action.

Key words: surfactants, detergents, free radical oxidation processes, radiotoxins.

The surfactants have been widely used in all sectors of the economy as the synthetic and technical detergents. In particular, they have been demanded in light and chemical industry, building and agriculture, ferrous and non-ferrous metallurgy, perfumes, microbiological and medical industry etc. A human systematic contacts with surfactants as in manufacture as in household [1,4,8,10,11,12,20,22]. Numerous data of literature evidence about multidimensional impact of surfactants on the living organisms [5,8,11,12].

This review of literature describes the structural and metabolic disorders in different organs and systems of organs caused by surfactants. This is important for creating a concept of mechanism of biological action of the surfactants.

The physiological and biochemical system of complicated organization provides homeostasis.

Any prepathological and pathological condition appears as a structural and functional disorganization of the metabolic systems.

* To cite this English version: T.M. Popova, N.V. Zharova, I.L. Kolesnik, A.V. Apolonina, V.V. Pogorelov, A.V. Titkova, I.Yu. Bagmut, V.I. Zhukov The typical pathochemical reactions of the damaging impact of detergents as sources of radiotoxins // Problemy ekologii ta medytyny. - 2015. - Vol 19, № 5-6. - P. 14-16.

The main role of biological membrane receptors is known in the regulation of living processes and their are disturbed by environmental influence [17].

Toxic factors induce several changes in the cytoskeleton which lead to the synthesis of the second messenger and via further steps, functional cell restructuring occurs. According to the concepts about structure of biological membrane the membrane phospholipids are bound with lipid-dependent enzymes [6].

Disturbance of lipids peroxidation are important as a reason of the structural and functional disorders of biological membranes. This process leads to the membrane systems have been broken and several pathological conditions have been developed [3].

The influence of surfactants was found on lipids and proteins structure of cell membranes. The increase of speed of lipids peroxidation may be associated with significant elevation of concentration erythrocyte and hepatocyte membrane components such as lysophosphatidylcholine, phosphatidylethanolamine and phosphatidylcholine, which was caused detergents [6,7,8,11].

The body has effective mechanism for inactivating and then excreting xenobiotics through biotransformation in liver, lungs, kidneys, skin, spleen, adrenal glands etc. However, biotransformation mainly take place in liver and with the help of oxidation-reduction and conjugation reactions foreign substances are modified. Then they are eliminated by excretory systems. These enzymes of biotransformation are located in mitochondria, microcosms, endoplasmic reticulum or hyaloplasm [6].

The main biochemical laboratory is the smooth endoplasmic reticulum of hepatocytes occurs the detoxification of chemical compounds by biotransformation. The smooth endoplasmic reticulum is rich in membrane bound enzymes, which catalyze partial reactions in the lipid metabolism as well as biotransformation [4,8].

The influence of detergents on the O-demethylase activity of microsomes was experimentally researched. There was observed the activation of demethylation processes and a dose dependence of them. Activity of cytochrome c-reductase was increased by all of detergents, so an impact was demonstrated on two microsomal electron transport chains. The speed of endogenous respiration, oxidation of NADPH, NADH was increased by xenobiotics. It has also been shown that activation of processes of demethylation in monooxygenase system of liver microsomes and two microsomal electron transport chains may occur under the influence of surfactants. They lead to evaluation of concentration of enzymes cytochrome P₄₅₀ system, excepting cytochrome b₅. Thus, the research results indicate that surfactants increase the speed of lipid peroxidation [7, 8, 9].

The mechanism of free radical oxidation is base of oxidation of surfactants. During the process of oxidation of surfactants appear a lot of toxic metabolites which have radiomimetic properties [8,9,12].

The products of biotransformation were substances such as acetaldehyde, ethyl ether, propionaldehyde, dimer formaldehyde, methanol, ethyl acetate, methyl ethyl ketone, ethanol, butyraldehyde, allyl aldehyde, crotonaldehyde, dioxane, diacetone alcohol, isopropyl alcohol [7,8,9]. In opinion of several authors A.M. Kuzin, Y.B. Kudryashov, V.A. Kopylov these metabolites are emitters of radiotoxins [13,14,15,16,18,19,25]. The radiomimetics have membrane-tropic effect, mutagenic, embryotoxic and gonadotoxic influence. They accelerate lipid peroxi-

ation, suppress humoral and cellular immunity [8,9,10,12,13,14,18,23,27].

It should be noted, that free radical oxidation occurs in all of the body's tissues. The free radical oxidation is an important part of metabolism. In addition, the low concentration peroxides and hydroperoxides are just necessary for normal living, although in fact, an increase of concentration of them lead to pathology [2,3].

During intensification of lipid peroxidation occur the increase in absorption of oxygen by hepatocyte mitochondria, concentration of diene conjugates and malondialdehyde in blood serum and chemiluminescence of urine of experimental animals. In the tissues the diene conjugates and malondialdehyde are appeared and accumulated by activation of free radicals. It is known that damage of cell's membranes occur under the influence of peroxides and hydroperoxides [2,3,8,16,18].

A decrease in the amount of red blood cells and leukocytes of experimental animals after prolonged administration by different pathways of detergents were discovered. According to data of researches of E.B. Burlakova the accumulation of free radicals, peroxides and hydroperoxides lead to a significant decrease in synthesis of DNA, RNA and protein, a mitotic activity of bone marrow cells [8]. On the other hand, decrease of red blood cells may be associated with destruction of thiol-containing compounds such as cysteine, glutathione, vitamin C, haptoglobin [8,9,10].

A lot of experimental researches of the antioxidant system showed a decrease the concentration of the following enzymes: creatine kinase, phosphofructokinase, Ca²⁺, Mg²⁺-ATPase, catalase, peroxidase, glutathione peroxidase, lactate dehydrogenase, glucose-6-phosphate dehydrogenase, aldolase, cholinesterase in tissues of animals. At the same time, activity of these enzymes were enhanced in blood plasma.

Due to the low concentration of CO₂ (P<0,05), which was breathed by experimental animals confirmed the depletion of the antioxidant system and slowing the metabolism of experimental animals. Thus, the profound structural and metabolic restructuring is tightly linked with a structurally functional condition of biological membranes which damaged by products of intensive lipid peroxidation. [8,9,11,12].

V.I. Zhukov et al. have observed that the concentration of copper, sodium, potassium, magnesium, zinc, iron and calcium was decreased in different animal's organs while concentration of them was increasing in the blood serum. Therefore the detergents have a membrane damaging effect which supports the output of micro- and macro- elements from cells to blood stream [7,8,11,12].

Neurotransmitters are actively involved in the processes of adaptation and play a significant role in the reactions of the sympathetic-adrenal and hypothalamo-pituitary-adrenal-cortical system. The reaction of the body was directly changed by radiotoxins and the changes were tightly correlated with the condition of the cytoplasmic membrane receptors, adenylyl cyclase system and the intracellular mediators. The concentrations of dopamine, norepinephrine and serotonin were increased in the brain, at the same time, the concentrations of noradrenalin, serotonin and tryptophan were enhanced in the liver of experimental animals. Assessment of the changes showed significant activation of GABA-glutamate system as protective-adaptive reaction of the organism to the action radiomimetic agents [8,9].

Therefore, radiotoxins are the products of biotransformation, which have a direct effect on the structure of the plasma membrane. The results of many authors show that the membrane is a main part of the pathogenesis of the biological action of detergents. The profound structural restructuring occurs in the biological membranes. Membrane pathology leads the development of atherogenesis, cardiovascular disease, diabetes, tumors and many other diseases.

Acknowledging the radiomimetic properties of surfactants and the fact that detergents are widely used in our life, it becomes necessary to develop a complex system of anti-radical protection of the population.

The topic about radiotoxins is an integral part for researching of patho-chemical reactions are influenced by detergents. The team of authors plans to develop and improve new diagnostic methods of free radicals oxidation and radioprotective methods.

Implementation of the results opens up opportunities for a fundamental interpretation of the mechanisms ecologically caused diseases, which are based on membrane free radical pathology.

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Матеріал надійшов до редакції 01.03.2016