The advantage of UV irradiation of environmental samples in conjunction with ecotoxicity studies

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Abstract. The soil toxicity can be assessed following the growth inhibition of green alga in soil elutriat. UV transformation of organic matter content, like humic acids, PAH compounds, heavy metal according with their oxidative status and water solubility or other unknown substances from soil should be much more toxicants for exposed algas. A descriptive analysis of the susceptibility of different compounds to be converted in the presence of UV radiation, in relation with its ecotoxicity is achieved in this article.
Key Words: soil elutriat, UV irradiation, algal inhibition, aquatic toxicity.

Introduction. The understanding of exposure hazard to a mixture of contaminants in various environmental samples has a great interest for ecotoxicology (Artigas et al 2012). Although biological-ecotoxicological tests with algae in the foreground are not accurate indicators of environmental effects, they should be regarded as the best and at the same time the most avilable methods of analyzing the effects of multiple contaminants (Garbo & Ciorba 2011).

The algae growth inhibition test. The estimation of aquatic toxicity to multiple contaminants found simultaneously, in order to identify the hazard can be achieved using the algae growth inhibition test according to OECD recommendation no. 201, which has been revised in 2011.

The exposure assesment is focused both on acute and chronic toxicity of the volatile compounds, heavy metals, toxic chemicals, materials with low solubility, also waste water or pesticides. It can perform screening and characterization of effluent toxicity, monitoring of effluent toxicity until the toxicity limit, the estimation of the wastewater discharged impact from punctual sources, but also the assessing of water quality.

A final report of the USEPA (2013) states that the test is of great interest in the following areas: Toxicology, Public Health and Occupational Medicine, Environmental Health and Safety, Environmental and Occupational Factors.

Various nonpunctual source pollution (urban, industrial or agricultural) may lead to contamination of the sediment/soil with various toxic substances. The effects of these pollutants can be observed in the short term (e.g. exposure to heavy metals, the chlorophenol) or long term (exposure to polychlorinated biphenyls, PCBs and polycyclic aromatic hydrocarbons, PAHs). Determined individually these substances may be present in lower concentrations than the recommended references. In time, however, through their synergistic effect they can reach a sharp deterioration of the environment, manifested by the destruction of ecosystems and loss of biodiversity by alteration the ability of the environment to return to the original characteristics.

The application of algal growth inhibition test in soil elutriat is of great interest in assessing the industrial areas contamination (Sbrilli & Batistini 2011). In the soil analysis, this test corresponds with the qualitative assessment of the presence of any toxic substances in soil, sediment or water column above. As we know, the concentrations of persistent toxic substances in the sediments are higher, through their storing, after the sedimentation process. In the water column above, the concentrations are usually much lower because here the toxic substances cannot be stored due to their remobilization and bio-disponibilization.

The UV irradiation of environmental samples. The application of UV irradiation in conjunction with the algal growth inhibition test are allowing to obtain effects, with

different magnitude. The toxicity of present substances can be directly influenced. They can convert into more or less toxic substances depending on their individual properties.

The pH, salinity or the response of other microorganisms from the water or soil samples are influencing the algae growth. The irradiation time and its intensity has an influence on the inducted effects (Purmalis & Klavins 2013).

Following the irradiation response of various components from the soil, we observed that humic substances from soil and sediments are also susceptible to be direct transforming under the action of UV radiation (Mahvi et al 2009). The humic substances are found 70-80% in the sediments, and serve as chelating substances on the various components present in the aqueous medium. Depending on the origin of humic substances, the soil or sediments properties are different.

According to Wetzel et al (1995), UV radiation degrades photolytically the dissolved organic carbon in soil. Humic substances, which are quite resistant to bacterial degradation, after the UV irradiation will be converted into products of formaldehyde, acetaldehyde, glyoxylate, pyruvate, etc.

UV-B irradiation of samples with *Gyrodinium aureolum* germs, in which the amount of Aldrich humic acid has been supplemented led to the growth inhibition of germs. Increased susceptibility of transforming of the phenolic groups from humic substances composition was assumed to be the cause of the observed toxicity by generating of reactive radicals such as superoxide ($O_2^{\cdot -}$) (Nielsen & Ekelund 1993).

The susceptibility of algae to be bacterial degraded is independent of the absorbent properties of colored humic substances when the algae inoculum was placed in contact with UVB irradiated water and kept in darkness for 8 hours. On the other hand, the bacterial degradation of algae in the presence of humic substances, is the consequence of direct photochemical reactions between the humic substances with dissolved organic carbon (Tranvik & Kokalj 1998).

Environmental contamination with heavy metals is considered to be a health hazard for all the living organisms from water and soil, for the vegetals, animals or human (Ivanova & Groudeva 2006). The metal toxicity in sediments depends on their chemical state, on their water or sediment biodisponibility and on the living organisms sensitivity. Biodisponibility of metals is affected by the presence of organic matter, e.g. humic acids. Humic acids, produced by degradation of organic matter and by microorganisms, are able to form bounds with a variety of metals from their carboxyl groups. The UV transformation of humic acids in soil may have an indirect effect on the metal toxicity through alteration of their biodisponibility. The adsorption or complexation of particles with dissolved organic substances may reduce toxicity. The oxidation state of metals according to their form is difficult to be characterized, while the toxicological studies are generally performed through assessment of their concentrations. In real environmental samples, the observed toxicity is still not enough correlated with their effective concentration (Tsiridis et al 2006).

These aspects can induce an alteration in the predictability and risk assessment studies. The variation of toxicity by UV irradiation can be explained by the effect of free radicals, on the redox potential of the metals, and depends on the aqueous pH solutions. At low pH, the metals exist generally as free cations, but at the alkaline pH they tend to precipitate as insoluble hydroxides, carbonates, oxides or phosphates, which leads so to a reduction of their toxicity.

The complex combination, humic substances – metals, may present a certain toxicity, higher or lower depending on the pH. In general, the toxicity of these combinations is due to their phenolic composition and ionisable organic composition. This will be even greater as pH decreases, as a result of the metal precipitation. It has been observed the increased inhibition of algal growth with the decrease of soil pH and interstitial water (Tsiridis et al 2006).

PAH and polycyclic aromatic hydrocarbons are an important group of micropollutants coming from fossil fuels, the burning of organic matter and the transformation of natural organic matter in the environment (Shemer & Linden 2007). Environmental contamination with PAHs is common in the natural environment, and their identification is more important due to their mutagenicity, teratogenicity and

carcinogenicity in small doses. In water they can be associated with suspended material particles, due to their hydrophobicity, followed by deposition process in sediments, (Chiou et al 1998). At their turn, they are susceptible to be transformed under the action of UV radiation. After their UV irradiation, in aqueous elutriat, they will generate the second toxic products, such as: highly reactive hydroxyl radicals, organic radicals, phenols, quinones, acids, that will directly influence the growth of algae in respectives aqueous solutions.

Conclusions. The UV irradiation of environmental samples, in conjunction with the algal growth inhibition test, may have real advantages. The variation of algae response after the irradiation of environmental samples in some particularlly exposure, could be interpreted as an effective evidence of increased susceptibility in the transformation of toxic substances.

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