Use of cyclodextrin to estimate environmental risk caused by organic compounds

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Abstract

It has been realized, that the amount of organic pollutants extracted by solvents from soil may not relate to the environmental risk. Ecotoxicological test results have higher relevancy to the real environmental effects and risk. The relevancy can be increased by the application of full soil tests or by measuring bioavailability of the contaminant in the soil. The assessment of the bioavailability of contaminants in the soil is considered highly relevant to understand the risk posed by a contaminant and the means required for successful risk assessment. The results of whole soil toxicity tests integrate the effects of the interactions between soil matrix and testorganism, but the toxicity buffering effect of the soil often causes negative results.

This work is an example of how cyclodextrines (CD) increase the biovailability of contaminants in soils polluted with high K_{ow} organic pollutants. Cyclodextrin addition increases bioavailability and bioaccessibility of the strongly bound contaminants, without diluting the soil.

In case of high K_{ow} pollutants the water extract of the soil has often no measurable effect on the test organism. In such cases we can use toxically indifferent organic co-solvents or other solubilising agents to produce measurable biological effect.

Cyclodextrins are well-known and widely used solubilising agents for high K_{ow} organic compounds. We tested the application of cyclodextrin for soils polluted with typical soil contaminants: transformer oil, phenantrene and pentachlorphenol (PCP). The mobilising effect of the CD was followed both by chemical analysis and toxicity testing, like whole soil toxicity test and Ames mutagenity test.

In acute toxicity tests the treatment of the soil with cyclodextrin increased bioavailability and resulted in a decrease of the dehydrogenase enzyme activity of soil microorganisms, but the lethal effect on Collembola decreased. Cyclodextrines have different effect on high K_{ow} organic pollutants, they may increase bioavailability but simultaneously may shield the effective ligand of contaminant.

When applying CD during the Ames test, the mutagenity of the PCP increased significantly, causing an increase in the sensitivity of the test. Mobilisation and solubilisation of contaminants means also an increase of bioavailability.

Our results show that cyclodextrin is a suitable agent for simulating bioavailability of high K_{ow} contaminants in the soil. Cyclodextrin could increase the sensitivity of the mutagenity test and also of some acute soil toxicity measuring tests. The results produced by cylodextrin pre-treatment of the soil might overestimate mutagenity and acute toxicity. This kind of overestimate fits well to the conservative concept of the environmental risk assessment procedure.

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