Influence of selected cyclodextrins in sorption-desorption of chlorpyrifos, chlorothalonil, diazinon, and their main degradation products on different soils

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Abstract

Cyclodextrins (CDs) can improve the apparent solubility and bioavailability of a variety of organic compounds through the formation of inclusion complexes; accordingly, they are suitable for application in innovative remediation technologies of contaminated soils. However, the different interactions in the tertiary system CD/contaminant/soil matrix can affect the bioavailability of the inclusion complex through the possible sorption of CD and CD complex in the soil matrix, as well as with the potential of the sorbed CD to form the complex, concurrent with the desorption processes. This work focuses in changes produced by three different CDs in soil sorption-desorption processes of chlorpyrifos (CPF), diazinon (DZN), and chlorothalonil (CTL), and their major degradation products, 3,5,6-trichloro-2-pyridinol (TCP), 2-isopropyl-6-methyl-4-pyrimidinol, and hydroxy-chlorothalonil (OH-CTL). Cyclodextrins used were beta-cyclodextrin (beta-CD), methyl-beta-cyclodextrin (M beta-CD), and 2-hydroxypropyl-beta-cyclodextrin (HP beta-CD). The studied soils belong to the orders Andisol, Ultisol, and Mollisol with different organic matter contents, mineral composition, and pH. The apparent sorption constants were significantly lower for the three pesticides in the presence of all CDs. The highest displacement of sorption equilibria was produced by the influence of M beta-CD, with the most pronounced effect for CPF, a pesticide strongly sorbed on soils. The same was obtained for TCP and OH-CTL, highlighting the need to assess the risk of generating higher levels of groundwater contamination with polar metabolites if degradation rates are not controlled. The highest desorption efficiency was obtained for the systems CPF-beta-CD, DZN-M beta-CD, and CTL-M beta-CD. Since the degree of adsorption of the complex is relevant to obtain an increase in the bioavailability of the contaminant, a distribution coefficient for the complexed pesticide in all CD-soil-pesticide system was estimated by using the apparent

sorption coefficients, the stability constant for each CD-pesticide complex, and the distribution coefficients of free pesticide.

Keywords

Author Keywords: Pesticides; Cyclodextrin; Constant binding; Sorption-desorption; Soil; Distribution coefficients

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