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Abstract

Soil Contamination by Pharmaceutical Pollutants: Adsorption of an Antibiotic (Amoxicillin) on an Agricultural Land †

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Abstract: Antibiotics are prescribed in human and veterinary medicine for the treatment of infectious diseases. They are also widely used for animal farming, aquaculture and agriculture. Antibiotics are not fully absorbed and metabolized and are therefore, often excreted unmodified. As sewage plants are not equipped to remove these drugs from wastewater, antibiotics may be discharged into the environment and reach the soil in many ways. The pharmaceutical industry, hospital and municipal wastewater containing antibiotics may be used for irrigation and animal manure, whilst sewage sludge and biosolids are frequently used as fertilizers for agricultural lands. This allows antibiotics to contaminate soil, ground water and the entire food chain. The major concern about antibiotics in the environment is their contribution to the resistance development in human and animal pathogens that can lead to a serious threat to human health. There are several procedures that determine the fate of antibiotics in soil such as transport, leaching, plant uptake, photodegradation, biodegradation and adsorption. The adsorption of these drugs into the soil depends on its physico-chemical characteristics (Cation Exchange Capacity, pH, permeability, iron oxide content, etc.), texture, organic matter and climate conditions. However, the assessment of the literature shows that more studies need to be carried out on the occurrence, fate and risks associated with antibiotics in the soil. For this purpose, the adsorption of an antibiotic widely used in human and veterinary medicine (amoxicillin) in an agricultural soil was studied. This experimental study was carried out in order to investigate the influence of several parameters: the contact time, the initial antibiotic concentration, the pH and the temperature on the contamination risk of soil by adsorption. These experiments showed that the adsorption of amoxicillin in soil is rapid. For a liquid/solid ratio of 10 L/kg and an initial antibiotic concentration of 10 ppm, the adsorption equilibrium was reached within 20 minutes and the maximum amount of amoxicillin adsorbed was of 23 mg/kg. The adsorption kinetics were well described by the pseudo-first-order model and exhibited a three-stage intra-particle diffusion mode. The adsorption capacity of soil increased with the initial antibiotic concentration (from 10 to 100 ppm) and the relative adsorption isotherm (type II) was in accordance with the Guggenheim-Anderson-deBroer model. The adsorption of amoxicillin was improved in the acidic medium. The thermodynamic study showed that the adsorption of amoxicillin in soil was a physical process. The overall study shows that amoxicillin is a potential contaminant for soil.

Keywords: soil contamination; pharmaceutical pollutants; adsorption; risk assessment