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Impact of soil properties on selected pharmaceuticals adsorption in soils

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The presence of human and veterinary pharmaceuticals in the environment has been recognized as a potential threat. Pharmaceuticals may contaminate soils and consequently surface and groundwater. Study was therefore focused on the evaluation of selected pharmaceuticals adsorption in soils, as one of the parameters, which are necessary to know when assessing contaminant transport in soils. The goals of this study were: (1) to select representative soils of the Czech Republic and to measure soil physical and chemical properties; (2) to measure adsorption isotherms of selected pharmaceuticals; (3) to evaluate impact of soil properties on pharmaceutical adsorptions and to propose pedotransfer rules for estimating adsorption coefficients from the measured soil properties. Batch sorption tests were performed for 6 selected pharmaceuticals (beta blockers Atenolol and Metoprolol, anticonvulsant Carbamazepin, and antibiotics Clarithromycin, Trimetoprim and Sulfamethoxazol) and 13 representative soils (soil samples from surface horizons of 11 different soil types and 2 substrates). The Freundlich equations were used to describe adsorption isotherms. The simple correlations between measured physical and chemical soil properties (soil particle density, soil texture, oxidable organic carbon content, $CaCO_3$ content, pH_H_2O, pH_KCl, exchangeable acidity, cation exchange capacity, hydrolytic acidity, basic cation saturation, sorption complex saturation, salinity), and the Freundlich adsorption coefficients were assessed using Pearson correlation coefficient. Then multiple-linear regressions were applied to predict the Freundlich adsorption coefficients from measured soil properties.

The largest adsorption was measured for Clarithromycin (average value of 227.1) and decreased as follows: Trimetoprim (22.5), Metoprolol (9.0), Atenolol (6.6), Carbamazepin (2.7), Sulfamethoxazol (1.9). Absorption coefficients for Atenolol and Metoprolol closely correlated (R=0.85), and both were also related to absorption coefficients of Carbamazepin (R=0.67 and 0.68). Positive correlation was found between Trimetoprim absorption coefficients and Atenolol, Metoprolol or Carbamazepin absorption coefficients. The negative relationship was found between absorption coefficients of Sulfomethoxazol and Clarithromycin (R=-0.80).

Sulfamethoxazol absorption coefficient was negatively related to pH_H_2O, pH_KCL or sorption complex saturation and positively to the hydrolytic acidity or exchangeable acidity. Trimetoprim absorption coefficient was positively related to the oxidable organic carbon content, cation exchange capacity, basic cation saturation or silt content and negatively to particle density or sand content. Clarithromycin absorption coefficient was positively related to pH_H_2O, pH_KCL, $CaCO_3$ content, basic cation saturation or sorption complex saturation and negatively to hydrolytic acidity or exchangeable acidity. Atenolol and Metoprolol absorption coefficients were positively related to the oxidable organic carbon content, cation exchange capacity, basic cation saturation, salinity, clay content or silt content, and negatively to the particle density or sand content. Finally Carbamazepin absorption coefficient was positively related to the oxidable organic carbon content, cation exchange capacity or basic cation saturation, and negatively to the particle density or sand content.

Evaluated pedotransfer rules for different pharmaceuticals included different sets of soil properties. Absorption coefficients could be predicted from: the hydrolytic acidity (Sulfamethoxazol), the oxidable organic carbon content (Trimetoprim and Carbamazepin), the oxidable organic carbon content, hydrolytic acidity and cation exchange capacity (Clarithromycin), the basic cation saturation (Atenolol and Metoprolol).

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