**Fate and behavior of pharmaceutical sulfonamide antibiotics in agricultural soils**

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Pharmaceutical antibiotics such as sulfonamides are mostly polar and amphoteric compounds. After administration they are quickly excreted from the medicated organism and reach agricultural soils through the use of contaminated manure, sewage sludge or wastewater for fertilization or irrigation. Consequently, the fate of these compounds takes place in a ternary mixture of soil solids, soil solution and biosolids/manure.

The extent of sorption differs among antibiotic classes and – to a lesser extent – within classes and mostly depends on specific mechanisms, resulting in non-linear sorption isotherms. Sorption is governed by soil organic matter (SOM) with functional groups of high polarity being preferred binding sites. Relevant mechanisms are van-der-Waals forces and hydrogen bonds but also - interactions of less polar molecular moieties with aromatic ring systems of the sorbent. The contribution of hydrophobic partitioning is controversially discussed. Additionally, the pH dependent speciation strongly modifies sorption and charged species interact via ion exchange and cation bridging not only with SOM but also with clay minerals and pedogenic oxides.

After addition to soil, mild-solvent extractable concentrations rapidly decline, which is mostly attributed to surface complexation but also ligand exchange. On a longer term, diffusion into and sequestration in micropores as well as transformation occur, the latter resulting in the formation of soil bound residues, metabolisation and biodegradation. Yet, the latter processes appear to be subordinate.

Manure and biosolids as complex mixtures of mostly organic compounds, strongly influence the sorption and transport of antibiotics in soil. Resulting mobilization or immobilization very much depends on the particle size, chemical composition and pH of the manure or biosolid constituents on one hand and the properties of the sulfonamides, especially logD on the other hand.

Often antibiotics are not applied as single substances but in mixtures of two or more active substances or accumulate upon collection of manure or biosolids in storage tanks. Consequently, mixtures of antibiotics end up in soil, where competitive sorption may occur. Sorption competition was found for antibiotics from one structural class as well as between antibiotics from different classes.