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Abstract

Investigations on the fate of veterinary pharmaceuticals in soil

Veterinary pharmaceuticals, especially tetracyclines and sulfonamids, are used in large quantities in animal husbandry and reach the soil via manure or slurry application. After exposure to soil the parent compounds and metabolites may reach the food chain via plant uptake and contaminate ground water. In addition to ecotoxicological effects, veterinary antibiotics may promote the development and spread of resistant bacteria. But due to insufficient knowledge on occurrence and fate (degradation, transport) of pharmaceuticals in soil a reliable risk assessment is not possible.

This work aimed to get more information on the fate of the veterinary antibiotics chlortetracycline (CTC) and sulfadiazine (SFD) in manured soil. Therefore, soil samples from field and column experiments were analyzed.

For the analysis of soil samples LC-MS methods were developed and applied. The sample preparation of this method included a solid/liquid extraction with ammoniacal EDTA-buffer as well as a further clean-up and preconcentration via solid phase extraction (SPE). CTC was determined as sum of iso-CTC (isomer of CTC) and e-iso-CTC (epimer of iso-CTC) because of fully isomerisation under ammoniacal extraction condition.

The data of field experiments under farming conditions show that already a single application of manure is resulting in a measurable contamination of soil top layers (plough layer) for months. Repeated manure application leads to an accumulation of antibiotics in soil. Therefore higher antibiotic recovery rates from soil were noticed after the second manure application. Transfer into deeper soil layers was not detected.

The results of the field experiment were basically confirmed by further experiments with soil columns (near-natural or extreme rainfall). The analyzed leachate samples of the column experiments contained small amounts of the applied antibiotics. This indicates a possible leaching for CTC and SFD into groundwater. Hence, the generally accepted assumption that CTC is immobile in soil and cannot reach groundwater is to reconsider. Although the mechanism of transport is not fully clear, the results indicate a particle-facilitated transport of CTC.

The leachate samples showed significant losses in the quantifiable amount of CTC. Systematic experiments reveal that these losses can be attributed to occlusion of CTC by soil-matrix. This process caused that only a small part of total CTC was extractable. CTC complex formation with metal ions may be also responsible for lower recovery.

Preliminary experiments with fluorescence methods were carried out for direct determination of CTC in soil. Results with test-particles (aluminium oxide, sand, clay, soil) show that determination of particle-sorbed CTC is in principle possible.