Tracing soil sorption and plant uptake by spinach (*Spinacia oleracea*) and radish (*Raphanus sativus*) of five antibiotics – experimental test with spiked soil

I. Nybom[1,2], S. van den Broek [1], T. D. Bucheli [2], C. S. McArdell[3], G. Garland[1]

[1]ETH Zurich, Department of Environmental Systems Science, Zürich, Switzerland, [2]Agroscope, Environmental Analytics, Zürich, Switzerland, [3]Eawag, Department Environmental Chemistry, Dübendorf, Switzerland

Antibiotic residues are widely detected in agricultural soils and animal manure fertilizers, and thus have the potential to be taken up by plants cultivated in such soils. The fate of five antibiotics were studied in an experimental greenhouse trial. The antibiotics of interest were applied as a mixture into a model agricultural soil, representative for Swiss agricultural soils, at increasing concentrations (0, 0.1, 1, and 10 mg/kg for each individual antibiotic). The selected antibiotics consisted of clarithromycin (CLA), enrofloxacin (END), chlortetracycline (CTC), sulfamethoxazole (SMZ) and trimethoprim (TMP), which represent a range of characteristics including cationic (CLA), zwitterionic (END, CTC) and anionic (SMZ, TMP) species dominating under the experimental conditions (soil pH 7.4). Spinach (*Spinacia oleracea*) and radish (*Raphanus sativus*) were grown in the spiked soil, under controlled environmental and climatic conditions for 6 weeks, after which time the crops were harvested. Collected soil and plant samples were extracted for antibiotics with QuEChERS (**Qu**ick, **E**asy, **Ch**eap, **E**ffective, **R**ugged, and **S**afe) method (potassium phosphate buffer: acetonitrile with 5% formic acid, 1/1 vol/vol and acetonitrile with 1% acetic acid correspondingly). The soil LOQs were 3.2 µg/kg for CTC, and < 0.5 µg/kg for the CLA, END, SMZ, and TMP. The absolute recovery for CTC was 70%, and for other antibiotics with isotope labelled available the relative recoveries ranged between 100 and 107%. Pore-water was collected by separating it from the soil by centrifugation. Soil and pore-water samples collected in the course of the experiment (day 0, 2 days, 1 week, 3 weeks and 6 weeks), showed different degradation behaviour between the antibiotics. For example, in the 1 mg/kg concentration half-lives of CTC, SMZ, TMP were 0.9, 3 and 8 days, respectively. However, the concentrations of CLA and END remained constant throughout the experiment, and as a result their concentrations were the highest after six weeks of exposure (CLA>END>CTC>SMZ>TMP). The measured soil pore-water concentrations from the same treatment (1 mg/kg) were highest for CLA and SMZ, followed by TMP, whereas CTC was not detected. The sorption coefficients (Log Kd) for CLA, TMP and SMZ after 6 weeks were 1.9, 0.9 and 0.8, respectively. Based on the differences in the antibiotic sorption behaviour and pore-water concentrations, differences in the uptake and translocation of the antibiotics in plants can be expected. The extractions of the plant above- and belowground fractions are currently ongoing.