

Irrigation of root vegetables with treated wastewater: Evaluating uptake translocation and metabolism of pharmaceuticals

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To meet mounting water demands, treated wastewater has become an important source of irrigation. Thus, contamination of treated wastewater by pharmaceutical compounds and the fate of these compounds in the agricultural environment are of increasing concern. This field study aimed at quantifying uptake of pharmaceutical compounds by root crops (carrots and sweet potatoes) grown in lysimeters and irrigated with treated wastewater or fresh water. The lysimeters (0.5 m³) contained three soils ranging in their clay and organic matter content. The treated wastewater were provided by a conventional activated-sludge wastewater-treatment facility and spiked by a series of pharmaceutical compounds.

In both crops, non-ionic pharmaceutical compounds (carbamazepine, caffeine, and lamotrigine) were detected at significantly higher concentrations than ionic pharmaceutical compounds (metoprolol, bezafibrate, clofibric acid, diclofenac, gemfibrozil, ibuprofen, ketoprofen, naproxen, sulfamethoxazole and sildenafil). The concentrations of the taken up pharmaceutical compounds were higher in leaves than in the roots.

Carbamazepine was taken up and bioconcentrated at the highest level among the studies pharmaceutical compounds. Thus we further analyzed plant samples for its main metabolites. The metabolite 10,11-epoxycarbamazepine was detected in all roots, leaves and soil samples. The parent compound was dominant in the soil and roots, while 10,11-epoxycarbamazepine was dominant in the leaves of both crops.

The health risk associated with consumption of wastewater-irrigated root vegetables was estimated using the threshold of toxicological concern (TTC) approach. This is a conservative estimate that is based on 5% of the level at which there are no observed adverse effects with an additional 10⁻⁶ factor. Our data show that the TTC value of lamotrigine can be reached for at a daily consumption of half a carrot (~60 g) and two carrots a day (~180 g) for a child and adult, respectively. This study highlights the need for additional research on the exposure to pharmaceutical compounds contaminated crops in order to determine a level of toxicity, leading to future regulation of acceptable levels in treated wastewater used for irrigation to ensure no risk from this new class of environmental pollutants.