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Assessing the environmental availability of sulfamethoxazole and its acetylated metabolite in agricultural soils amended with compost and manure: an experimental and modeling study

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The recycling of sludge compost and farmyard manure in agriculture can lead to the introduction of sulfonamide antibiotics and their acetylated metabolites into soils. The quality and the biodegradability of the exogenous organic matter (EOM) containing antibiotic residues is determinant for their environmental availability and fate in soils (Goulas et al., 2016). This study combined experimental and modeling approaches in order to: 1) assess the fraction of sulfamethoxazole (SMX) and N-acetyl-sulfamethoxazole (AcSMX) available in EOM-amended soils by using soft extractions (CaCl2, EDTA or cyclodextrin solutions) during a 28-day incubation; and 2) better understand the dynamics of sulfonamide residues in amended soils in connection with their availability and the mineralization of EOM organic matter thanks to the COP-Soil model (Geng et al. 2015). This model proposes several options to couple the biotransformation of organic pollutants (OP) with the decomposition of EOM in soil. The microbial degradation can be simulated by co-metabolism and specific-metabolism. The model also accounts for the formation of non-extractable residues (NER) via both physicochemical and microbial routes.
The available fraction in both soil/EOM mixtures decreased from 56-96% and 31-63% initial 14C-activity for AcSMX and SMX, respectively, to reach 7-33% after 28 days. This high decrease in the first seven days was mainly due to the formation of NER that were more abundant in soil/manure mixtures than in the soil/compost ones. The three aqueous solutions differently extracted the available 14C-residues according to the incubation time, the EOM and the molecule. The mineralized fractions for both 14C-molecules were only 2-3% with a little more mineralization in the soil/manure mixtures than in the soil/compost. By using the COP-Soil model, the dynamics of EOM and OP were well described using parameter values specific to the organic matter mineralization, and this for the three soft extractants used. Others parameter values were common to both EOM and both sulfonamide compounds when coupling the dynamics of OP to EOM with the assumption of co-metabolism. The set of parameter values describing the pollutant fate strongly differed according to the soft extractant, confirming different mechanisms of extraction. Globally, the best OP simulations were obtained for the CaCl2-based extraction.

Keywords
Sulfonamides; environmental availability; recycling; organic matter; modeling

References

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