

Public Abstract

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Title:SORPTION AND TRANSPORT OF VETERINARY ANTIBIOTICS IN AGROFORESTRY BUFFER, GRASS BUFFER AND CROPLAND SOILS

Veterinary antibiotics (VAs) such as oxytetracycline (OTC), sulfadimethoxine (SDT) and sulfamethazine (SMZ) may adversely impact human health and environmental quality. Understanding sorption and transport of VAs is important for assessing the risk of VAs reaching surface or groundwater resources. Vegetative buffer strips (VBS) affect soil properties that enhance removal of organic pollutants and thus may be a useful tool for mitigating veterinary antibiotic transport from agricultural lands. Therefore, the objectives of this study were: (1) measure the sorption and retention of veterinary antibiotics to soils collected from three different soil series each planted to agroforestry buffer (AGF), grass buffer (GBS), and row crops (RC), and determine the soil physical and chemical properties governing antibiotic sorption to these soils; (2) investigate changes in VA sorption and retention to VBS and cropland soils in the presence of manure-derived dissolved organic matter (DOM); (3) study and model VA transport through soil columns repacked with VBS and cropland soils in presence and absence of manure-derived DOM. Sorption experiment results show that OTC was strongly adsorbed by all soils and was not readily extractable, whereas SDT and SMZ sorption to soils were weak and therefore highly mobile in soils. The sorption isotherms for OTC and SMZ were well fitted by the Freundlich isotherm model. Further investigation of solid-to-solution partition coefficients (K_d) revealed that vegetative management had a significant ($P < 0.01$) influence on SMZ sorption and followed the order $AGF > GBS > RC$, and for OTC sorption $VBS > RC$. Significant differences in K_d values for these VAs were also noted among the soil series studied. Linear regression analyses indicate that clay content and pH were the most important soil properties controlling OTC and SDT adsorption, respectively. For SMZ, organic carbon content, pH, initial SMZ concentration, and clay content were the most important factors controlling sorption. Study of the two most contrasting soils revealed that increasing solution pH from 6.0 to 7.5 greatly reduced SMZ sorption to the Armstrong GBS soil, but little pH effect was observed for the Huntington GBS soil. Although the presence of DOM had little effect on Freundlich model parameters, DOM resulted in slightly lower SMZ K_d values, presumably, due to competitive interactions between the VA and DOM for sorption sites. Transport study including ^{14}C -labeled SMZ or SMZ plus DOM and non-reactive tracer bromide was conducted in saturated columns packed with Huntington soil (silt loam) planted to AGF and RC. Bromide breakthrough curves were fitted with an equilibrium model within the CXTFIT software, whereas SMZ breakthrough was fitted with the HYDRUS-1D software using two-site and three-site models with linear or Freundlich sorption components. Results indicate that the three-site model containing two reversible sites and one irreversible site coupled with the Freundlich sorption component (3S2R-Freu-irrev model) best describes SMZ transport through the columns with model efficiencies of 0.998, 0.994, and 0.991 for AGF, AGF + DOM and cropland soils, respectively. Fitted sorption parameters such as K_d , K_f and N are in the same range of those obtained from equilibrium sorption experiments. DOM effects were not observed due to diluted DOM concentration. Data from equilibrium sorption experiments and column transport experiments suggest that the AGF soil has a larger capacity to retain SMZ than the cropland soil. Overall, this research facilitates our understanding of VA sorption and transport in the environment and supports the use of vegetative buffers to mitigate VA loss from agroecosystems.