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Facilitated transport of lincomycin, oxytetracycline, and sulfamethoxazole in saturated sand by black carbon nanoparticles

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Black carbon (BC) nanoparticles are generated by natural wildfires or engineered processes, and can be considered a unique phase in the continuum of organic matter present in soil and water environments. In this study, we investigated the facilitated transport of three antibiotics (lincomycin, oxytetracycline, and sulfamethoxazole) by BC nanoparticles in saturated sand columns at solution ionic strength (IS) of 0.1, 1, and 10 mM and pH of 7. Our results showed that in the absence of BC nanoparticles, lincomycin transport increased with increasing IS, but no IS effect was observed for sulfamethoxazole and oxytetracycline. Under all tested IS levels, injected sulfamethoxazole was completely transported, and injected oxytetracycline was completely retained. In the presence of BC nanoparticles, three antibiotics were sorbed by BC nanoparticles and co-transported through the column. The BC-facilitated transport of lincomycin, oxytetracycline, and sulfamethoxazole decreased with increasing IS due to enhanced deposition of BC nanoparticles at greater IS. More intriguingly, lincomycin was released from the deposited BC nanoparticles at 10 mM IS, whereas sulfamethoxazole was released from the deposited BC nanoparticles at 0.1 mM IS, and no oxytetracyline release was observed. The total transport of injected antibiotics were enhanced in the presence of BC nanoparticles at 0.1 mM IS, but decreased at higher IS, implying that the facilitated transport of antibiotics by BC nanoparticles would most likely occur under rainfall or irrigation with low-salinity water.