Effects of Sewage Sludge-Chinese Medicinal Herbal Residue-Biochar Amendment on Antibiotics and Antibiotic Resistance Genes (ARGs) in Agricultural Soil

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Background

Human overuse and misuse of antibiotics have caused antibiotic resistance worldwide that is an emergent threat to the environment. Antibiotic resistance genes (ARGs) have been promoted but little is known about the variations in ARGs of tetracyclines after the application of sewage sludge-Chinese medicinal herbal residue-biochar (SL-CMHR-BC) amendment in soil system and plant growth. This study demonstrated that CMHR can decrease the abundance of ARGs and reduce the risk of ARGs spreading in the farmland land that is the effective way to solve the antibiotic pollution problems in terrestrial environments.

Research Objectives

- evaluate the potential impacts of antibiotics contamination on the generation and transfer of antibiotic and antibiotic resistance genes bioaccumulation mechanisms in the soil-plant system.
- determine an effective way to solve antibiotic pollution problems in terrestrial environments, as well as decrease the ecological risks of ARGs and their potentially adverse effects on human health through the food chain.

- test the hypothesis that SL-CMHR-BC amendment has an inhibitory effect on antibiotic and ARG bioavailability in soils and crop accumulation.

Methodology

Preparation

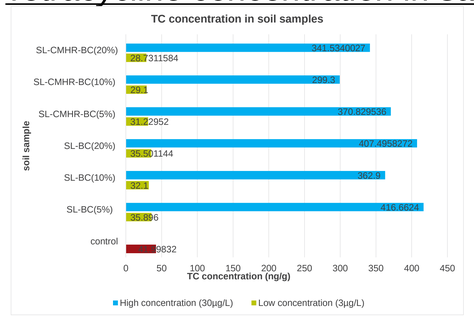
Tetracycline (TC) and six ARGs (tet A, tet B, tet C, tet E, tet M, tet O) were studied. Sewage sludge (SL) was collected in one municipal sewage treatment plants. SL should be stabilized biologically and chemically under aerobic fermentation and be treated with lime and be dried in a solar dryer. The quality of biochar (BC) depended on the characteristics and status of biomass during its synthesis. The Chinese medicinal herbal residues (CMHR) were collected from the School of Chinese Medicine, the Chinese University of Hong Kong, and CMHRs samples were stored at 4°C to minimize decomposition.

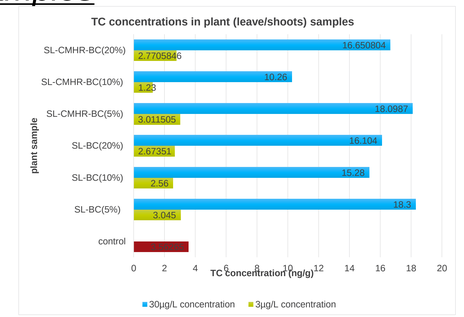
Experimental Design

Soil had a high abundance of antibiotic-resistant bacteria and ARGs as cultivation soil in this greenhouse experiment and wastewater with high concentrations (30 μg/L) and low concentrations (3μg/L) of antibiotics irrigated to soil. Lettuce was grown as the target crop. 3-4 kg ARG-treated soil was put in pots with lettuce being grown from seed. Two hundred millilitre of antibiotic-treated wastewater were applied to each pot every day. Leaves/shoots was harvested when it reached marketable size (90 days) for biomass and antibiotic determination, whereas the soil in pots were collected for antibiotic concentration, antibiotic-resistant bacterium and ARG abundance analysis.

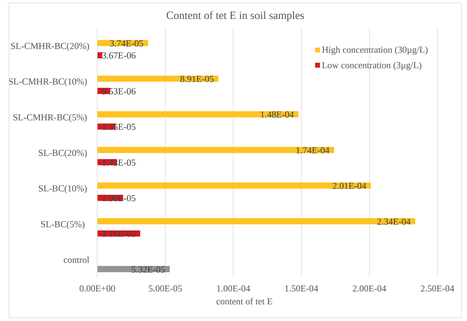
Findings

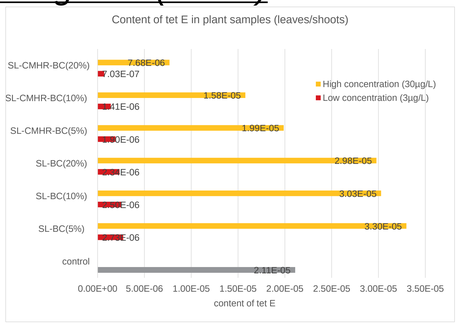
Tetracycline concentration in samples



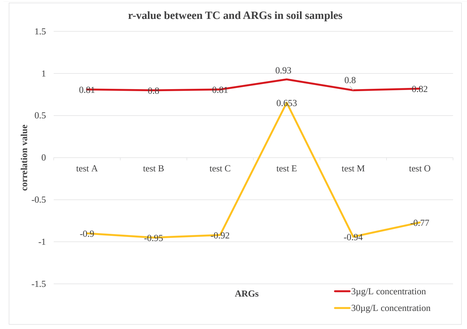


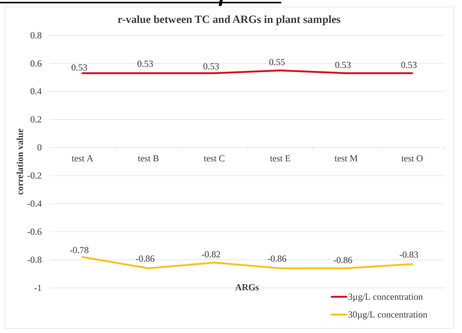
Abundance of antibiotic resistance genes (ARGs)





Correlation between TC and ARGs in soil samples





Conclusion

All ARGs were reduced except tet E which was increased significantly after application of SL-BC, and it would be reduced after applying CMHR as soil amendment. Addition of CMHR performed more effectively on inhibition than SL-BC and higher ratio of CMHR also had better inhibition ability.