Sheep and Rapeseed Cake Manure Promote Antibiotic Resistome in Agricultural Soil

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Abstract

The application of manure in agriculture caused the emergence and spread of antibiotic resistance genes (ARGs) and antibiotic-resistant bacteria (ARB) in soil environments. However, the co-occurrence pattern and host diversity of ARGs and MGEs in soils amended with animal and green manures remains unclear. In this study, metagenomic assembly and binning techniques were employed to comprehensively explore the effects of sheep manure and green manure on soil microbiome, antibiotic resistomes, and ARG hosts. The results obtained in this study showed that both sheep manure and rapeseed cake manure significantly altered the microbiome and enhanced the relative abundance of ARGs in the soils, and SM-amended soil samples showed a higher level of antibiotic resistance. Metagenomic assembly and binning analysis revealed distinct co-occurrence patterns of ARGs and MGEs in both GM- and SM-amended soils samples, showing significant differences in MGE types associated with quinolone, rifampicin, sulfonamide, and tetracycline resistance genes. The widespread coexistence of AGR-MGE promoted the horizontal gene transfer of ARGs in soil and increased the potential mobility of ARGs. Mobile genetic elements (MGEs), such as plasmids, transposases, and integrases, preferentially enhanced the potential mobility of some ARGs subtypes (i.e. sul2, aadA, qacH, and folp), facilitating the spread of ARGs. Additionally, sheep manure reshaped the bacterial community structure and composition as well as ARG hosts, some opportunistic pathogens (i.e. Staphylococcus, Streptococcus, and Pantoea) acquired antibiotic resistance and remained recalcitrant. It is concluded that rapeseed cake manure and sheep manure increased the co-occurrence of ARGs and MGEs, enriched the potential ARG hosts, and promoted the dissemination of ARGs in agricultural soils. In view of the risks posed by ARGs, it is recommended to replace animal manure with green manure, and strengthen soil management.