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Detection of antibiotic residues and characterization of antibiotic-resistant potential of bacteria in compost samples in Sri Lanka

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Antibiotic residues in the environment contribute to the survival and growth of antibiotic-resistant bacteria (ARB) by applying selective pressure on microbial populations. This enables the quick spread of antibiotic-resistant factors among various bacterial populations in the environment. This research aimed to detect antibiotic residues in compost and determine the presence of ARB in compost samples. A total number of 11 samples including 6 Municipal Solid Waste (MSW) samples and 5 commercial compost samples were collected for the study. Amoxicillin (AMX), Tetracycline (TET), Cloxacillin (CLOX), and Ciprofloxacin (CIP) were selected as antibiotics to be determined in the samples. The selected antibiotics in the samples were concentrated using the Solid Phase Extraction (SPE) and detected by High-Performance Liquid Chromatography (HPLC). The standard pour plate technique on Nutrient Agar (NA) medium was used to isolate the total viable counts. The ARB was isolated and Minimum Inhibitory Concentrations (MIC) were measured according to the Clinical and Laboratory Standard Institute (CLSI) guidelines, using nutrient broth. The results indicated the absence of antibiotic residues in compost samples. MSW compost had a higher total viable count as well as ARB count (TVC; 224×10^4–368×10^4 $CFUmL^1$: ARB; 20×10^4–47×10^4 $CFUmL^{-1}$) compared to commercial compost (TVC; 50×10^4–198×10^4: ARB; 2.5×10^4–18×10^4). Sixty-eight morphologically different bacterial isolates were counted for the selected antibiotics. Among them 37% exhibited resistance to AMX, 35% to CLOX, 15% to TET, and 13% to CIP. None of the isolates recorded the MIC ranges between 60 and 180 μgmL^{-1}. From the selected 4 antibiotics, 28% isolates for AMX, 12% isolates for CLOX, 22% isolates for CIP, and 20% isolates for TET showed the MIC ranges between 180 and 300 μgmL^{-1}. From the total isolates, 32% bacterial isolates for AMX, 4% bacteria isolates for CLOX, and none of the isolates for CIP and TET showed MIC between 300 μgmL^{-1} and 420 μgmL^{-1}. Further, 4% bacterial isolates for AMX, 17% bacterial isolates for CLOX, and none of the isolates for CIP and TET showed MIC between 420 μgmL^{-1} and 660 μgmL^{-1}. Thirty-six percent isolates for AMX, 67% isolates for CLOX, 78% isolates for CIP, and 80% isolates for TET, which showed more than 660 μgmL^{-1} concentration of MIC. The overall results of this study revealed that the selected compost creates a reservoir for antibiotic-resistant bacteria. There can be a spread of ARB, even under the absence or lower concentrations of antibiotic residues than the instrument detective level (0.05 ppm). Higher MIC values indicate the requirement of greater antibiotic doses for pathogen control, which could create severe health risks.

Keywords: Antibiotic residues, Antibiotic resistance, Compost, Minimum Inhibitory Concentration

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