INNOVATIVE BIOFERTILIZATION STRATEGIES FOR MITIGATING EMERGING CONTAMINANTS IN SUSTAINABLE AGRICULTURE

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Climate change, biodiversity loss, and increasing environmental pollution constitute a "triple planetary crisis," demanding innovative and sustainable approaches across all sectors, particularly food production and agriculture. The increasing demand from consumers for safe, chemical-free agricultural products, including those free from pesticide residues and other pollutants, further drives the need for alternative farming practices. While the extensive application of fertilizers and agrochemicals has historically enabled high yields, it poses significant risks to human health, including farmers, and the environment. Transitioning from conventional intensive agriculture to sustainable organic practices requires the implementation of green solutions and the active transfer of knowledge from research and development to end users.

In this context, the present study investigated the effects of *Bacillus licheniformis* and *Bacillus safensis* on tomato (*Solanum lycopersicum*) growth cultivated on the medium (agar) contaminated with selected pharmaceutical active compounds (PhACs) and pesticides, as well as their potential to mitigate the uptake of contaminants of emerging concern (CECs). Tomato plants were initially grown on CEC-contaminated media for 14 days, followed by bacterial treatment, with cultivation continuing for an additional 10 days. Subsequently, an optimized QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) extraction protocol was applied to isolate selected CECs from the medium, roots, and stems, with extracts analyzed using ultra-high-performance liquid chromatography coupled to tandem mass spectrometry (UHPLC-MS/MS). The results demonstrated that the presence of selected CECs did not significantly affect stem biomass. However, treatment with *B. safensis* significantly increased root biomass, highlighting its potential for plant growth promotion. Differential accumulation patterns were observed for the tested CECs: phosphamidone, imazalil, furosemide, and losartan predominantly remained in the medium; methidation, linuron, sotalol, and salbutamol accumulated in roots; whereas carbofuran, dimethoate, carbamazepine, and propranolol were enriched in stems. Notably, foliar treatment reduced the uptake of certain compounds, including omethoate and ethoprophos, indicating an effective mitigation strategy.

These findings underscore the potential of *Bacillus*-based biofertilization/biofortification technologies to enhance plant growth while reducing CEC accumulation in edible tissues. The study provides a framework for developing sustainable agricultural practices that integrate microbial interventions to mitigate environmental contamination and protect food quality.

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