Combined effect of biosurfactants and plants on the Bioavailability and biodegradation of PAHs in contaminated soil: an integrated chemical and microbiological approach

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Background/Objectives

The project aims to enhance the biological degradation of polycyclic aromatic hydrocarbons (PAHs) in soil through a multifactorial approach combining biosurfactants (rhamnolipids and saponins) and phytoremediation using *Festuca arundinacea*. The study focuses on evaluating total PAH concentrations and bioavailability in contaminated soils and assessing the influence of surfactant addition and plant presence.

Methods

PAH-contaminated soil was collected from a creosote-polluted site in southern Spain. Mesocosm experiments (5g – 1Kg soil) were conducted under different conditions, including the presence or absence of *Festuca arundinacea* and the application of rhamnolipids (50, 150, 400 mg/Kg of soil) and saponins (500, 4000, 8000 mg/Kg of soil). Surfactants were applied 3 times after a preliminary biostimulation phase. PAH bioavailability dynamics were monitored throughout the experiment. Total PAHs were extracted using a Soxtherm system, while the bioavailable fraction was assessed with the Tenax method (20 h extraction). Soil microbial community structure will be analyzed by 16S rRNA gene sequencing (ILLUMINA platform).

Results and Conclusions

Biostimulation of contaminated soil resulted in a substantial decrease in PAH concentrations within 55 days, with a notable reduction in low- and medium-molecular-weight PAHs and a slower decrease in high-molecular-weight PAHs. Subsequent treatments with saponins and *Festuca arundinacea* were particularly significant in this context, promoting a reduction in total PAH concentrations over time and highlighting the importance of a preliminary biostimulation phase. The applied surfactant concentrations were selected based on prior laboratory-scale mesocosm tests, which evaluated their effects on PAH mobilization and bioavailability. Conversely, systems treated with rhamnolipids exhibited greater contaminant mobilization. Overall, the results confirm the potential of integrated strategies to optimize the bioremediation of contaminated soils.