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Production of Electricity in an Electrobiochemical Slurry Reactor used for the Bioremediation of Pesticide Contaminated Soil

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ABSTRACT

It is recognized that mass transfer of lindane from soil to liquid phase is the limiting process in biodegradation processes used for soil bioremediation. Surfactants are used due to their ability to increase water solubility and mass transfer. On the other hand, electrobiochemical slurry reactor (EBCR) constitutes a promising technology that could remove organic matter, phenol, petroleum hydrocarbons, and pesticides in contaminated soils with simultaneous electricity output. The aims of this research were *(i)* to evaluate the desorption of lindane from soil with Tween 80 at different concentrations; *(ii)* to determine the power output and removal of lindane in an electrobiochemical slurry reactor; and (*iii*) to characterize the dominant microorganisms in the electrobiochemical slurry reactor using 16S rRNA and denaturing gradient gel electrophoresis. The EBCR consisted of a Plexiglass cylinder approximately 6 cm in diameter and 8 cm in length, fitted with two anodes and two cathodes.

Addition of 2000 mg /L Tween 80 removed 9.61% of lindane in *in vitro* desorption experiments. The internal resistance of the EBCR determined by polarization curve was 820 Ω; a moderate volumetric power activity was recorded (374 mW/m^3) along with a potential of 600 mV when the two-electrode sets were connected in parallel. During the batch operation, the EBCR showed a 56% lindane removal whereas the reduction in the abiotic control was 3%. Unexpectedly the removal efficiency of lindane ($\eta_{lindane}$) in the EBCR was lower than that in an EBCR operated without surfactant in a previous experiment. This could be ascribed to the increased degradable organic matter supply related to Tween in our EBCR that possibly shifted microbial metabolism from lindane degradation to degradable matter uptake. An average volumetric power of 685 mW/m^3 and average voltage of 420 mV were achieved. Results from the DGGE analysis and further sequencing, indicate the presence of *Trichococcus palustris* strain DSM 9172 (99% sequence identity). This bacterium has been reported in autotrophic biocathodes of other bioelectrochemical systems. Finally, the energy output obtained in our EBCR allows for the recovery of 20% of the power required for mixing, thus paving the way to sustainable bioremediation of soils.

Keywords: Electrobiochemical slurry reactor, lindane, Tween 80