EXECUTIVE SUMMARY

Thesis title: Bioavailability of polycyclic aromatic hydrocarbons and its impact on bioremediation

This thesis investigated the microbial degradation of polycyclic aromatic hydrocarbons (PAHs) in liquid and soil matrices and the influence of PAH bioavailability on biodegradation and ecological/ human exposure. These research themes were investigated using three PAH contaminated Soils collected from a former wood preservation site, a former manufacturing gas plant and a tram yard site in South Australia.

Enrichment of PAH contaminated soils on phenanthrene and pyrene resulted in the isolation of four phenanthrene and seven pyrene degrading pure cultures. Based on 16S rRNA analysis eight genera of PAH degrading bacteria were identified including *Mycobacterium* sp., *Burkholderia* sp., *Sphingomonas* sp., *Alcaligenes* sp., *Rhodanobacter* sp., *Sphingopyxis* sp., *Arthrobacter* sp. and *Afipia* sp. While *Mycobacterium* sp., *Burkholderia* sp., *Sphingomonas* sp., and *Alcaligenes* sp. have previously been shown to have the capacity to degrade PAHs, little information is currently available regarding the PAH degradative capabilities of *Rhodanobacter* sp., *Sphingopyxis* sp., *Arthrobacter* sp. and *Afipia* sp.

Liquid culture degradation experiment, utilizing PAHs as sole carbon and energy sources (50-250 mg 1^{-1}) demonstrated the varying degradative capacities of the isolated bacteria and reported for the first time PAH degradation by *Sphingomonas* sp. Str.Cep2, *Sphingopyxis ginsengisoli* str. Gsoil 250, *Burkholderia* sp.str.EC-V30-6, *Afipia genosp.* 8 str G8569 and *Alcaligenes* sp. F32. The research highlighted the role of the enrichment substrate on the metabolic versatility of the isolated microorganisms in addition to the enhanced metabolic capacity of microbial consortia compared to individual pure isolates.

When the degradative capacity of indigenous soil bacteria was assessed under natural attenuation (NA) and enhanced natural attenuation (ENA) conditions, NA of PAH contaminated soil was limited presumably due to a lack of nutrient availability. However, nutrient addition (nitrogen and phosphorus) resulted in the enhanced bioremediation of PAHs in contaminated soil resulting in an 18-36% (125-306 mg kg $^{-1}$) decrease in PAHs over a 77 day period. When comparing PAH rates from liquid to soil matrices, it was evident that solid matrices have significant effects on degradation. It has been proposed that contaminants mass transfer, from soil solid phase to solution, governs microbial bioaccessibility, particularly, the size of the rapidly desorbable fraction. However, not all biodegradable PAHs were reduced due to PAH bioaccessibility limitations in contaminated soil. While a number of methods may be used to determine PAH bioaccessibility, Hydroxypropyl-ß-Cyclodextrin (HPCD) extraction and persulfate oxidation provided a good estimation of biodegradable PAH compounds.

When the bioaccessibility of residual PAHs following ENA was determined using in vitro assays for human health expose assessment, the decrease in PAH concentration as a result of biodegradation resulted in a reduction in PAH bioaccessibility in post-remediated soil. In contrast, an increased toxicological effect was observed for *Eisenia fetida* and *Beta vulgaris* in post-remediated soils presumably due to the production of toxic PAH transformation products.

Contact

Dr. Ilia Rostami

Australian Research Centre for Environmental Risk Assessment and Remediation(CERAR)

University of South Australia, Mawson Lakes Campus, Adelaide, SA, 5095, Australia

Telephone: +618 8302 6245 / **Fax:** +618 8302 3057

Email: Rosiy002@mymail.unisa.edu.au

Homepage:
http://www.unisanet.unisa.edu.au/students/homepage.asp?Name=Ilia.Rostami%20Abusaidi
http://www.crccare.com/education/students/ilia_rostami_abusaidi.html