
This version is available at: http://eprints.mdx.ac.uk/21831/

Copyright:

Middlesex University Research Repository makes the University's research available electronically.

Copyright and moral rights to this work are retained by the author and/or other copyright owners unless otherwise stated. The work is supplied on the understanding that any use for commercial gain is strictly forbidden. A copy may be downloaded for personal, non-commercial, research or study without prior permission and without charge.

Works, including theses and research projects, may not be reproduced in any format or medium, or extensive quotations taken from them, or their content changed in any way, without first obtaining permission in writing from the copyright holder(s). They may not be sold or exploited commercially in any format or medium without the prior written permission of the copyright holder(s).

Full bibliographic details must be given when referring to, or quoting from full items including the author's name, the title of the work, publication details where relevant (place, publisher, date), pagination, and for theses or dissertations the awarding institution, the degree type awarded, and the date of the award.

If you believe that any material held in the repository infringes copyright law, please contact the Repository Team at Middlesex University via the following email address:

eprints@mdx.ac.uk

The item will be removed from the repository while any claim is being investigated.

See also repository copyright: re-use policy: http://eprints.mdx.ac.uk/policies.html#copy
ENHANCED VERMIREMEDIATION OF HYDROCARBON CONTAMINATION USING BIOSURFACTANT

S. Popoola, H. Jones, D. Purchase
Faculty of Science and Technology
Department of Natural Sciences, Middlesex University, London

BACKGROUND

Polycyclic aromatic hydrocarbons (PAHs) are components of crude oil and its by-products and are both recalcitrant as well as carcinogenic (Makker et al., 2003). The chemical, physical and thermal processes are the common techniques involved in the cleaning up of oil contaminated sites (Margesin and Schinner, 2001). These techniques, however, have some adverse effects (Dendooven et al., 2011). Moreover, several scholars have reported the ability of earthworms to enhance the removal of several soil contaminants such as polycyclic aromatic hydrocarbons, heavy metals, polychlorinated biphenyls (PCBs) and so on (Contreras-Ramos et al., 2008; Dendooven et al., 2011).

Soil properties

- Cation exchange capacity
- Soil heavy metal & organic matter
- Soil moisture content
- Soil pH
- Soil texture
- Soil microbial population

Carry out OECD toxicity test of both PAHs and biosurfactant on earthworm and microtoxicity

Assess the biotic and abiotic properties of the soil

OBJECTIVES

This research aims to investigate the removal of phenanthrene (PH) and fluoranthene (FL) by earthworms enhanced with rhamnolipid (biosurfactant) and their joint effect on the biochemical processes in epigeic (Eisenia hortensis) and anecic (Lumbricus terrestris) species of earthworms.

- Assess the biotic and abiotic properties of the soil
- Carry out OECD toxicity test of both PAHs and biosurfactant on earthworm and microtoxicity on indigenous soil microorganisms to determine LC50
- Determine the removal capacity of PAHs by Eisenia hortensis and Lumbricus terrestris with or without biosurfactant
- Explore and understand the enzymatic metabolism of PAHs, specifically EROD activity of CYP1A1 and their potential as biological indicators.

METHODOLOGY

RESULTS & DISCUSSION

Table 1: Soil properties

<table>
<thead>
<tr>
<th>Soil sample</th>
<th>KETTERING SOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.1 ± 0.02</td>
</tr>
<tr>
<td>Bacteria (cfu g⁻¹)</td>
<td>3.6 x 10⁹</td>
</tr>
<tr>
<td>Fungi (cfu g⁻¹)</td>
<td>5.6 x 10⁸</td>
</tr>
<tr>
<td>Actinomycetes (cfu g⁻¹)</td>
<td>5.5 x 10⁷</td>
</tr>
<tr>
<td>Soil organic matter (%)</td>
<td>3.9 ± 0.3</td>
</tr>
<tr>
<td>Soil moisture content (%)</td>
<td>4.9 ± 0.2</td>
</tr>
<tr>
<td>Fe (mg g⁻¹)</td>
<td>15.5 ± 2.2</td>
</tr>
<tr>
<td>Mn (mg g⁻¹)</td>
<td>0.27 ± 0.045</td>
</tr>
<tr>
<td>Pb (mg g⁻¹)</td>
<td>0.017 ± 0.002</td>
</tr>
<tr>
<td>Zn (mg g⁻¹)</td>
<td>0.025 ± 0.002</td>
</tr>
<tr>
<td>P (mg g⁻¹)</td>
<td>0.42 ± 0.01</td>
</tr>
</tbody>
</table>

Fig 4: comparative removal of FL and PH from treatment after 4 weeks in both Eisenia hortensis and Lumbricus terrestris. All data are represented as means ± SD of triplicates. (where S=soil, P=pollutant, B= biosurfactant, E=Eisenia, and L=Lumbricus)

CONCLUSION

Both epigeic and anecic species of earthworms have very good potentials to remove PAHs both 3 and 4 ringed hydrocarbons in the presence of rhamnolipid biosurfactant. Epigeic species appeared to be more tolerant to increased concentrations and environmental conditions compared to anecic species that were extremely sensitive to concentrations and environmental conditions around them. Their application to contaminated land does prove to be a promising and environmentally friendly technique in removing hydrocarbons from soils. However a major limitation for using anecic earthworm species would be environmental conditions to which they are exposed, and also a large amount of both species would probably be needed on the field as well as sufficient substrate for their growth and general activity.

REFERENCES


Dongueux et al, 2011). Furthermore, several scholars have reported the ability of earthworms to enhance the removal of several soil contaminants such as polycyclic aromatic hydrocarbons, heavy metals, polychlorinated biphenyls (PCBs) and so on (Contreras-Ramos et al, 2008; Dendooven et al, 2011).

Soil moisture content (%) 4.9
Soil organic matter (%) 3.9
Fungi (cfu g⁻¹) 5.6 x 10⁸
Actinomycetes (cfu g⁻¹) 5.5 x 10⁷
Soil organic matter (%) 3.9 ± 0.3
Soil moisture content (%) 4.9 ± 0.2
Fe (mg g⁻¹) 15.5 ± 2.2
Mn (mg g⁻¹) 0.27 ± 0.045
Pb (mg g⁻¹) 0.017 ± 0.002
Zn (mg g⁻¹) 0.025 ± 0.002
P (mg g⁻¹) 0.42 ± 0.01

Soil sample

- Extractable FL
- Extractable PH
- Fluoranthene (Dip1g)
- Fluoranthene (Dip2g)
- Phenanthrene (Dip1g)
- Phenanthrene (Dip2g)

Fig 5 (A&B): A comparative overview of FL and PH removal between treatments in both Eisenia hortensis and Lumbricus terrestris. All data are represented as means ± SD of triplicates. (where S=soil, P=pollutant, B= biosurfactant, E=Eisenia, and L=Lumbricus)

Table 1: Soil properties