A novel biodegradation system for hydrophobic organic pollutants considering pyrene as a model molecule

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Introduction

- **Polycyclic aromatic hydrocarbons (PAHs) are persistent organic pollutants.**
- **They may be genotoxic and *carcinogenic*.**
- **Low aqueous phase solubility and *negligible bioavailability* are major limiting factors towards their biodegradation.**
- **However, using oil *encapsulation technique* bioavailability of these compounds can be enhanced.**
- **In present study, *pyrene* was used as a model PAH compound.**
- **It was dissolved in silicone oil and mixed with an aqueous phase containing sodium *alginate (3% w/v)-polyvinyl alcohol* (PVA) (3% w/v), at 3:7 ratio.**
- **Mixture was *emulsified* using a surfactant, (Brij 30).**
- **Using resulting emulsion alginate-PVA microspheres prepared by *emulsion gelation technique*.**
- **A *chitosan coat* was applied on such microspheres.**
- **Prepared microspheres were used to deliver pyrene to *Mycobacterium frederiksbergense* for degradation.**

Results

❑ ***Preparation of pyrene encapsulated micro-spheres***

- **Based on emulsion stability, 3 % (w/v) PVA , 100 g/l brij 30 and 3:7 oil: aqueous phase ratio chosen for microsphere preparation.**
- **10 % $CaCl_2$ (w/v) and 3% (w/v) boric acid selected as gelling solution.**

❑ ***Characterization of the prepared beads***

- **Microsphere prepared using 3% alginate showed sustained release of pyrene.**
- **Chitosan coating of such microsphere further improved pyrene release behavior.**

❑ ***Pyrene biodegradation by M. frederiksbergense***

- **Pyrene biodegradation experiments carried out using oil encapsulated beads contining *500mg/l, 1000 mg/l and 2000mg/l* pyrene in silicone oil.**
- **In all cases nearly complete degradation of pyrene achieved without any lag phase in degradation.**

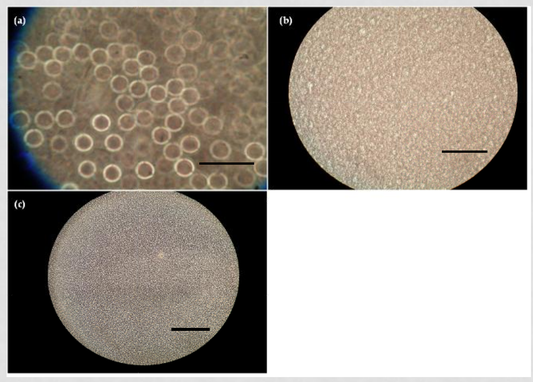

Fig.1: Photomicrograph of different emulsions prepared in the study. The scale bar represents 0.4 mm.

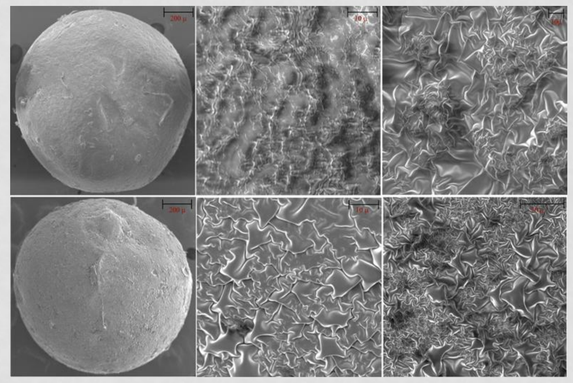

Fig.2: SEM images of chitosan coated (bottom panel) and uncoated (top panel) micro-spheres. Left-right: whole bead, bead surface, cross section (interior).

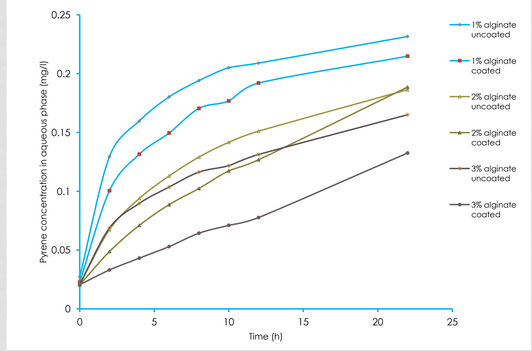

Fig.3: Effect of alginate concentration and chitosan coating on pyrene release pattern from the micro-spheres.

Fig. 4: Photograph of bioreactor vessel showing oil encapsulated bead suspended in aqueous media.

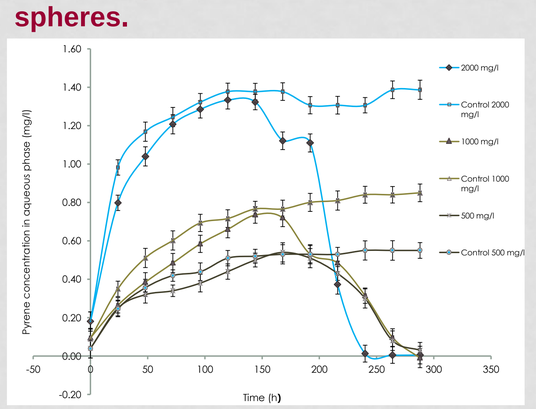

Fig.5: Degradation profiles of pyrene by *M. frederiksbergense* using the chitosan coated pyrene encapsulated alginate-PVA beads containing different concentrations of the PAH.

Conclusion

- ✓ **Silicone oil containing pyrene was successfully encapsulated in chitosan coated alginate- PVA beads.**
- ✓ **More than *99 % pyrene encapsulation efficiency* achieved.**
- ✓ **Chitosan coating of microsphere improved pyrene *release behavior.***
- ✓ **Employing such microspheres as delivery vehicle, nearly complete degradation of as high as 2000 mg/l pyrene achieved.**

Acknowledgement

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References

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- **Sarma, S. J., Pakshirajan, K. and Mahanty, B. (2011) Chitosan coated alginate-polyvinyl alcohol beads for encapsulation of silicone oil containing pyrene: a novel method for biodegradation of polycyclic aromatic hydrocarbons, *J. Chem. Technol. Biotechnol.* 86: 266–272 .**