

Laboratory Synthesised Model Unresolved Complex Mixture (UCM) Hydrocarbons: A Biodegradation Study

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Summary

Cyclohexyl alkyltetralins, which are believed to be good model hydrocarbon compounds for components of unresolved complex mixtures (UCMs) have been synthesised in this laboratory. To validate their candidacy as components of the UCM they have been subjected to rigorous experimentation based upon known properties of the UCM (toxicity, solubility, photodegradation). This study has monitored the biodegradability of these compounds using the bacterium strain *Pseudomonas fluorescens*, a known aliphatic and aromatic hydrocarbon degrader.

1. Introduction

Unresolved complex mixtures (UCMs) of hydrocarbons are an almost universal feature of environmental samples contaminated with weathered residues of petroleum (Gough and Rowland, 1990).

Gas chromatographically resolved hydrocarbons are removed or depleted by bacterial action during weathering processes, leaving a mixture of both non-aromatic and aromatic compounds (Thomas *et al.*, 1995).

It has been proposed that alkyltetralins are components of the aromatic UCM (Thomas, 1995 and Warton *et al.*, 1999).

Wraige (1997) and Sturt (2000), synthesised a series of alkyltetralins (Figure 1.) using a Haworth-type reaction.

Exposure of *Mytilus edulis* to compounds (I-III) exhibited similar toxicity effects (>70% reduction in filtering rate) to those observed after exposure to aromatic UCM (Smith *et al.*, 2001 and Rowland *et al.*, 2001).

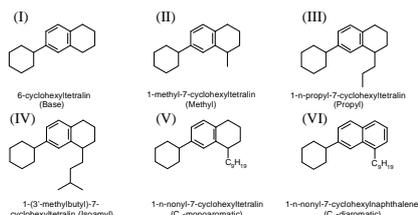


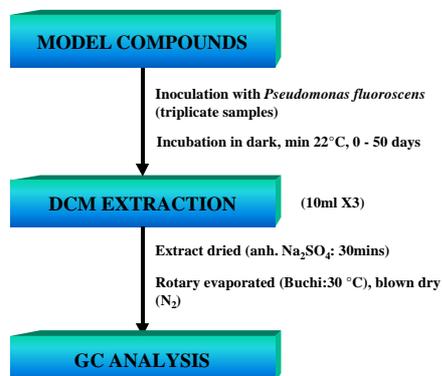
Figure 1: Chemical structures of the synthesised alkyltetralins (I-VI) used in the biodegradation experiment.

2. Aims

To support further the evidence for these compounds as good models of aromatic UCM components by undertaking biodegradation experiments using the bacterium *Pseudomonas fluorescens*, and to compare their degradation to that of a UCM (Gough, 1992).

3. Methods

The biodegradation experiments undertaken are based upon the methods employed by Robson and Rowland (1987) and Gough (1989).



References

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4. Results

At each sampling point samples of bacteria were taken and transferred to an agar nutrient plate. Observed growth over 24 hours confirmed the bacteria remained viable at each sampling stage (Figure 2.), and had no contamination from other bacteria species.

The concentration of lower molecular weight compounds has decreased (Figure 3).

The control samples show that all losses of hydrocarbons can be attributed to abiological effects. It is proposed that evaporation rather than photooxidative processes are responsible since the samples were kept in dark .

Figure 2: *Pseudomonas fluorescens* taken from viability test sample at day 50 (magnification x1000). Confirmed viability of a pure strain of the bacteria.

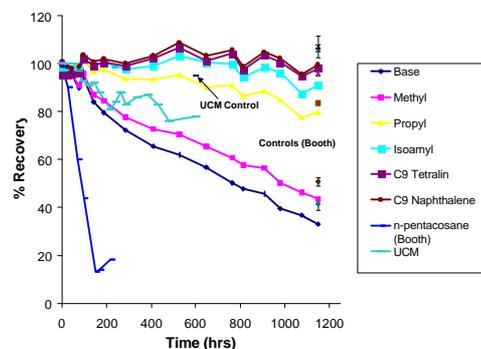
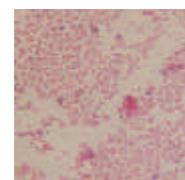


Figure 3: Summary of biodegradation data obtained herein show the percentage recovery of the alkyltetralins (I-VI) and controls over a 50 day period. Comparison UCM data supplied by Gough (1992).

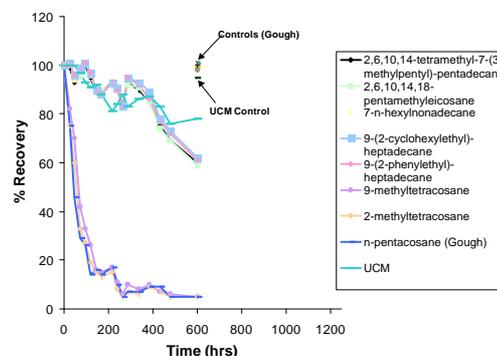


Figure 4: Summary of biodegradation data (Gough) showing the percentage recovery of proposed model aliphatic hydrocarbons and the aliphatic UCM, with controls, over a 25 day period.

5. Conclusions

Results show there was little bacterial degradation of any of the compounds, which supports their candidacy as model aromatic UCM components. The decrease in the concentration of compounds I and II is mainly attributed to evaporation.

6. Further Study

Whilst these data support the work previously undertaken, to be fully conclusive, these compounds should be exposed to a consortium of other known aromatic hydrocarbon degrading bacteria. It is hoped to start this next study soon.

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