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Analysis of Dibenzothiophene Biodegradation Products During ex situ Bioremediation of Soil Contaminated with Oil Pollutant

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The aim of this work was to investigate dibenzothiophene (DBT) biodegradation products formed during ex situ stimulated bioremediation of a soil contaminated with heavy residual fuel oil. A detailed description of the contaminated soil used, bioremediation experiment and microbial community employed is given in our previous paper (Beškoski et al., 2011). Presence of DBT and its methylated homologues in this soil has already been confirmed, as well as microbial activity in biodegradation of these compounds (Šolević Knudsen et al., 2015).

During six-month long ex situ bioremediation experiment, soil samples were taken five times in regular intervals. The soil samples were extracted in a Soxhlet apparatus with dichloromethane as a solvent. The extracts were cleaned up and fractionated using column chromatography. Target compounds were analysed by gas chromatography – mass spectrometry (GC-MS). The GC-MS analysis comprised numerous DBT oxygenated and hydroxylated derivatives, which are known as intermediary products of different DBT biodegradation pathways (Monot and Warzywoda, 2008). Of all DBT derivatives investigated in this research, 2-hydroxybiphenyl (HBP) was the only one identified in the soil samples analyzed. HBP was identified in the soil samples in the final phases of the experiment, when DBT was present in a low abundance, and later, when DBT was almost completely degraded. Detection of HBP, which is a product of, and marker for the 4S DBT biodegradation pathway indicates that corresponding metabolism might also be operational in the microbial community employed in this research. Additionally, presence of HBP in the soil samples when DBT was almost completely degraded indicates that this compound might be useful indicator of former DBT presence in soil even when DBT is completely degraded. Finally, these results indicate that biodesulfurization processes, which have already found application in removal of sulfur-containing compounds from crude oil and its derivatives, aiming at improving their quality, might also play a significant role in reduction of the environmental pollution from the fossil fuel contamination.


Notes
Sulfur-containing compounds from crude oil and its derivatives, aiming at improving their quality, might also play a useful indicator of former DBT presence in soil even when DBT is completely degraded.

Corresponding metabolism might also be operational in the microbial community employed in this research.

Biodegradation of these compounds (Šolević Knudsen et al., 2015)...

Degraded (Figures 1 and 2)...

Phases of the experiment, when DBT was present in a low abundance, and later, when DBT was almost completely

Mixing were performed each 2 weeks with powerful construction machinery. Biomass and nutritive substances were added one month by month and mixing the biopile. Biosurfactant of Biolute type was applied on the biopile at a concentration of 70 mL of the original solution per cubic meter of soil. After preparation, the biopile was covered with plastic foil to prevent direct influence of precipitation and low temperatures on the bioremediation material.

Simultaneously with the sampling from biopile, at the beginning of the experiment, immediately after mixing, but before the addition of sawdust, biomass, nutritive substances, and biosurfactant, samples were taken from the control pile.

The complete analytical procedure that was applied to the samples was also applied to the control samples.

During six-month long ex situ bioremediation experiment, soil samples were taken five times in regular intervals. The soil samples were extracted in a Soxhlet apparatus with dichloromethane as a solvent. The extracts were cleaned up and fractionated using column chromatography. Target compounds were analysed by gas chromatography – mass spectrometry (GC-MS). The GC-MS analysis comprised numerous DBT oxygenated and hydroxylated derivatives, which are known as intermediate products of different DBT biodegradation pathways (Manoj and Warrenwoold, 2008).

The compounds were identified by cojunction of authentic standards and matching of their spectra with those from the spectral library (NIST11).

RESULTS

Of all DBT derivatives investigated in this research, 2-hydroxybenzophenone (HBP) was the only one identified in the soil samples analysed. This compound was identified only in the control pile. HBP was identified in the soil samples in the final phases of the experiment, when DBT was present in a low abundance, and later, when DBT was almost completely degraded (Figures 1 and 2).

CONCLUSIONS

Detection of HBP, which is a product of, and marker for the 4S DBT biodegradation pathway indicates that corresponding metabolism might also be operational in the microbial community employed in this research.

Additionally, presence of HBP in the soil samples when DBT was almost completely degraded indicates that this compound might be useful indicator of former DBT presence in soil even when DBT is completely degraded.

Finally, these results indicate that biodesulfurization processes, which have already found application in removal of sulfur-containing compounds from crude oil and its derivatives, aiming at improving their quality, might also play a significant role in the reduction of the environmental pollution from the fossil fuel contamination.

REFERENCES


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