Effect of dissolved organic compounds in OSPW on toxicity of retene to early life-stages of Japanese medaka (Oryzias latipes)

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BACKGROUND

OIL SANDS PROCESS AFFECTED WATER (OSPW)

- Two constituents of tailings ponds that have the potential to cause toxicity to aquatic organisms, are polycyclic aromatic hydrocarbons (PAHs) and a variety of oxygen, sulfur, or nitrogen-containing compounds, including anionic surfactant naphthenic acids (NAs; CnH2n+2=nO2). However, PAHs are mainly sorbed to soils and thus became less available. Concentrations of alkylated polycyclic aromatic hydrocarbons (PAHs) are now greater in lakes around Athabasca oil sands (Alberta, Canada) after oil sands development compared to 50 years ago.

- Organic chemicals dissolved in oil sands process affected water (OSPW), have been characterized as surfactants and their toxic chronicity is not well characterized.

- Surfactants can increase accumulation of xenobiotic chemicals by altering membrane fluidity and by inhibition of ATP-binding cassette (ABC) transporter proteins that are important for efflux of xenobiotics from cells.

- A previous study showed that OSPW inhibits activity of ABC transporters in Caco-2 cells and larvae of Japanese medaka.

OBJECTIVES

Objective:

Since tailings ponds contain a mixture of naturally occurring surfactants, the goal of this study was to evaluate the effect of dissolved organic compounds in OSPW on a model alkylated PAH, 7-isopropyl-1-methylphenanthrene (retene) to early life stage Japanese medaka in the presence of environmentally relevant pH of dissolved organic compounds isolated from OSPW.

METHODOLGY

Methodology:

- Dissolved organic compounds extracted from OSPW by use of hydrophilic-lipophilic balance (SPE) solid phase at neutral pH.

- Embryos of Japanese medaka, four days post-fertilization, were exposed to retene in either freshwater or 5X equivalent of BML-OSPW in 20 mL glass vials until hatching by use of partition controlled delivery (PCD) system in which they dissolved in polydimethylsiloxane (PDMS).

- Retene added to a solution of PDMS dissolved in a mixture of DCM/Hexane.

- Mortality, deformities and time to hatch were measured.

- Concentration of retene in solution and in larvae were measured.

- Induction of CYP1a was compared among treatments.

RESULTS 1 – EFFECT OF OSPW ON ACCUMULATION OF RETENE

Table 1: Concentration of retene (µg/L) in solution media in vials with and without larvae. Retene was loaded into PDMS solution at 1 and 15 µg/L.

<table>
<thead>
<tr>
<th>Exposure media</th>
<th>Retene (µg/L)</th>
<th>PDMS + 1 µg/L</th>
<th>PDMS + 15 µg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 h</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>24 h</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
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<tr>
<td>48 h</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
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<tr>
<td>72 h</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
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<tr>
<td>96 h</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
</tr>
<tr>
<td>120 h</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
<td>1.08 ± 0.02</td>
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</tbody>
</table>

Concentration of retene compared to freshwater based solution, and enhance the accumulation of retene in larvae.

RESULTS 2 – EFFECTS OF CO-EXPOSURE TO RETENE AND OSPW

Figure 3: Percent incidence of pericardial edema of J. medaka following an 11-12-d exposure to PDMS loaded with (A) 1 µg/mL, and (B) 15 µg/mL with or without OSPW.

Conclusion: Co-expose retene with OSPW enhanced the incidences of deformities and the induction of cyp1a

Figure 4: Abundance of cyp1a transcripts of larvae of J. medaka following an 11-12-d to PDMS loaded with (A) 1 µg/mL, and (B) 15 µg/mL with or without OSPW.

DISCUSSION

There was no significant difference in concentrations of retene in water between vials with facility water (FW) or OSPW during exposure.

- Concentration of retene was greater in PDMS based OSPW compared to PDMS based water.

- Percent affected fish was greater in retene co-exposed with 5X OSPW (75.6%) than FW (44%).

- Expression of CYP1a was greater (127.4-fold) in retene co-exposed with 5X OSPW compared to exposure to retene in FW (82.28 fold).

- Whole body concentrations of retene were greater after 4, 6 and 24 h in fish exposed to 5X OSPW and retene compared to retene and water.

- Greater induction of CYP1a WAS likely due to greater bioavailability of retene in OSPW compared to freshwater.

Significance: Results suggest that OSPW might modulate toxicity of alkylated PAHs to early life stages of aquatic organisms. Exposure to OSPW at environmentally relevant concentrations (i.e. 1X) attenuated this effect. Future studies should focus on the long term exposure of adult fish to environmentally relevant concentrations (i.e. 1X) co-expose with other environmental contaminants.

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REFERENCES