Toxicity of Untreated and Ozone-treated Oil Sands Process-Affected Water to Early Life Stages of the Fathead Minnow (Pimephales promelas)

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ABSTRACT

The volume of Oil Sands Process-Affected Water (OSPW) currently stored in tailings in Alberta, Canada is greater than 1 billion m³. Additional research was required to ensure that ozonation of OSPW is one possible method for remediation of the concentrations of the organic constituents (AC-OSPW). Concentration of NAs in untreated OSPW was 19.7 mg/L (HPLC/HRMS). Concentration of NAs in AC-OSPW was 6.4 mg/L. NAs in O3-OSPW decreased approximately 30%. The results suggest that exposure to untreated OSPW or treatment of OSPW with activated carbon attenuated the effects on the abundances of transcripts of GST and SOD.

METHODS

To investigate mechanisms of toxicity by quantifying abundances of transcripts of target genes in embryos exposed to OSPW, q-RTPCR was performed.

RESULTS 1 – MORTALITY AND DEFORMITIES

Embryo Lethality

- Exposure to untreated OSPW caused significantly greater lethality.
- Ozonation of OSPW and treatment of OSPW with activated carbon attenuated the effects, with ozonation being more effective than activated carbon.

RESULTS 2 – GENE EXPRESSION

Metabolism of Xenobiotics

- OSPW did not affect CYP1A expression but significantly induced CYP3A. Therefore, dioxin-like compounds such as polychromatic hydrocarbons can be excluded as the causative agents.
- Expression of CYP3A is regulated by the pregnane x receptor (PXR) suggesting that agonists of the PXR are present in OSPW.
- CYP3A might metabolize organics in OSPW.

Response to Oxidative Stress

- Abundances of transcripts of GST and SOD were significantly greater in embryos exposed to untreated OSPW.
- Induction of SOD indicates that OSPW caused oxidative stress.
- Ozonation of OSPW or treatment of OSPW with activated carbon attenuated the effects on the abundances of transcripts of GST and SOD.

Regulation of Apoptosis

- Abundances of transcripts of genes involved with processes indicative of apoptosis (Caspla3 and ApoIn5) were significantly greater in embryos exposed to untreated OSPW.
- The results suggest that exposure to untreated OSPW has the potential to cause apoptosis.
- Ozonation of OSPW or treatment of OSPW with activated carbon attenuated the effects on the abundances of transcripts of Caspla3 and ApoIn5.

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