

Comparative Acute Toxicity of Three Perfluorinated Acids to *Pseudokirchneriella subcapitata*, *Daphnia magna*, and *Oncorhynchus mykiss*

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ABSTRACT

Perfluorinated compounds have unique properties and their measurement in various environmental matrices has received increased attention. While PFOS and PFOA have been the focus of much of this attention, other perfluorinated alcohols and acids are also of interest. We conducted 48, 72 and 96-hour aquatic toxicity tests to evaluate the acute toxicity of three perfluorinated acids to the cladoceran, *Daphnia magna*, the green alga, *Pseudokirchneriella subcapitata*, and the rainbow trout, *Oncorhynchus mykiss*, as part of an on-going product stewardship program. The three perfluorinated acids tested were 2-perfluorooctyl ethanoic acid, 2H-hexadecafluoro-2-decanoic acid, and n-perfluorodecanoic acid. The cladoceran, *Daphnia magna*, was generally the most sensitive species tested followed by the green alga, *Pseudokirchneriella subcapitata*. Rainbow trout were generally less sensitive to the fluorotelomer acids than the other test species. The results of the acute toxicity tests suggest that these perfluorinated acids are of medium concern based on their acute aquatic hazard. When coupled with available environmental exposure concentrations, these data suggest that the perfluorinated acids tested pose little acute risk for aquatic organisms.

INTRODUCTION

Perfluoroalkylated substances (PFAS) are compounds containing a $\text{C}_n\text{F}_{2n+1}$ group, or mixtures or formulations that contain such compounds. A wide range of chemical structures fall within this category including perfluorinated acids that may ultimately reach the aquatic environment, either directly or as degradation products of other perfluorinated compounds. While environmental persistence and potential environmental degradation of these compounds are important areas of research, the development of aquatic hazard data for use in environmental risk assessment is also important for those compounds that may reach aquatic ecosystems.

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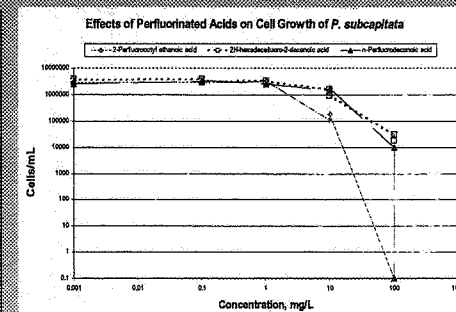
METHODS AND MATERIALS

- Test Species - *Pseudokirchneriella subcapitata*, a freshwater, green alga
- Source - Culture Collection of Algae - The University of Texas at Austin
- Culture Method - Miller et al., 1978; EPA-600-78-016; ASTM, 1990. E1218-90
- Test Method - screens based on OECD TG 201
 - 50 ml test solution in 250 ml Erlenmeyer w/ foam stoppers
 - nominal test substance concentrations - 0.1, 1, 10 and 100 mg/L
 - nutrient medium blank and abiotic control blank
 - 2 replicates per treatment (1 rep for abiotic), 10,000 cells/ml at initiation
 - 72 hour exposure without test medium renewal; pH at test start and end
 - env. chamber - 24 $\pm$ 2°C, 24-hr illumination - 6000 - 10000 lux, ~100 rpm
 - hemacytometer counts of cells at 24, 48, and 72 hours
- Test Species - *Daphnia magna*, a freshwater cladoceran from in-house culture
- Test Method - screens based on OECD TG 202
 - 48 hour static exposure; 200 ml test solution in 250 mL beaker
 - nominal test substance concentrations - control, 0.1, 1, 10 and 100 mg/L
 - 1 replicate per concentration or well water control, 10 < 24-hr neonates/rep
 - water bath at 20 $\pm$ 1°C, 16:8 photoperiod, 600 - 900 lux
 - pH, DO, temperature measured at study start and end
 - 48-hr immobility used as endpoint
- Test Species - *Oncorhynchus mykiss*, rainbow trout, Troutlodge, Summer, WA.
- Test Method - screens based on OECD TG203
 - 96 hour static exposure; 15 L test solution in 26 L stainless steel tank
 - Nominal test substance concentrations - control, 0.1, 1, 10 and 100 mg/L
 - 1 replicate per concentration or well water control
 - 5 fish per replicate; fish age ~43 - 47 days post-hatch
 - water bath at 12 $\pm$ 1°C, 16:8 photoperiod, ~250 - 500 lux
 - pH, DO, and temperature measured at test start and end
 - 96-hr lethality used as endpoint
- Test Compounds
 - 2-Perfluorooctyl ethanoic acid, CAS# 27854-31-5
 - a white solid - (C8F17CH2COOH), purity 99.4%
 - 2H-hexadecafluoro-2-decanoic acid, CAS# 70887-84-2
 - a white solid - (C7F15CF=CHCOOH), purity 99.8%
 - n-Perfluorodecanoic acid, CAS# 335-76-2
 - a white solid - (C9F19COOH), purity 99.6%

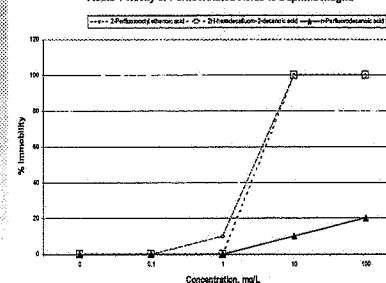
RESULTS

EC50 and Values (mg/L)

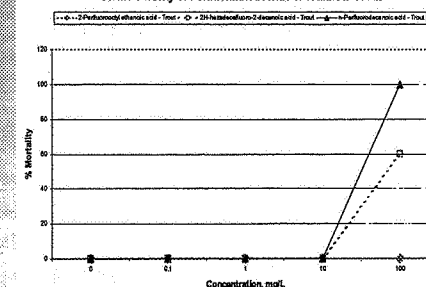
Compound	72-hr EC50, Green alga	48-hr EC50, Cladoceran	96-hr LC50, Rainbow Trout
2-Perfluorooctyl ethanoic acid	5.0 (2.0-7.9)	2.3 (0.9-5.6)	> 100
2H-hexadecafluoro-2-decanoic acid	7.5 (4.4-12.5)	3.2 (1-10)	81 (10-100+)
n-Perfluorodecanoic acid	10.6 (5.8-15.5)	> 100	72 (10-100)



Acute Toxicity of Perfluorinated Acids to *Daphnia magna*



Acute Toxicity of Perfluorinated Acids to Rainbow Trout



CONCLUSIONS

- The acute hazard of three perfluorinated acids to algae, daphnids, and fish was assessed during acute screening studies using nominal test concentrations of 0.1, 1.0, 10 and 100 mg/L for each test species and compound.
- EC/LC50s based on inhibition of healthy cell count, immobility and lethality were determined for algae, daphnids and fish, respectively.
- Daphnids were most sensitive to two of the test substances while algae were most sensitive to the third test substance. However, comparative algae and daphnid sensitivity were similar considering the range of normal laboratory variability in acute toxicity tests. Fish were much less sensitive (e.g. 3-10X) than either algae or daphnids.
- The test results suggest the three substances are of medium concern (i.e., EC50/LC50 > 1 mg/L but < 100 mg/L) for acute hazard to aquatic organisms (Smrček et al. 1995). Reported rainwater concentrations for the C10 acid (low pg/L, Loewen et al., PM059) extrapolated to surface waters suggest that the acute risk to aquatic organisms for these compounds is likely to be low.