Determining the LD_{50} of Perfluoroalkyl Acids to Joshua Trees

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Introduction

- Short-chain perfluoroalkyl acids (PFAAs) are characterized by their persistent, bioaccumulative and toxic properties. [1]
  - Longer carbon chains in PFAAs make the compound more nonpolar which increases bioaccumulation.
- These organic compounds are resistant to environmental degradation and have high thermal stability due to the strong C-F bonds. [1]
- Sources of PFAA's
  - Fire suppression foams, degradation of refrigerants, pyrolysis of Teflon, and degradation of chemicals containing a CF_3 functional group. [2]
- The chemicals used in this experiment are shown in Figure 1.

Objective

- **The purpose of this experiment was to compare the LD_{50} of C1 to C4 short-chain PFAAs in Joshua Tree (*Yucca brevifolia* Engelm.) seedlings.**

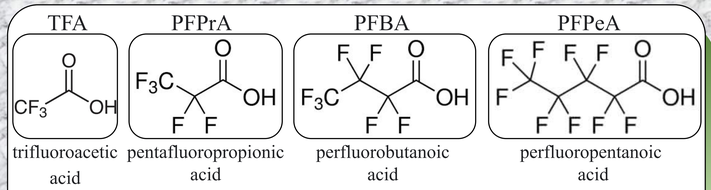

Figure 1. TFA, PFBA, PFPeA were included in the experiment.

Methods

- Glass vials were filled with 40g of Sonoran desert soil and 18.2 MΩ•cm water, then seeds were covered with parafilm and left to germinate until a viable plant size was reached.
- 120 plants were randomly selected to one of six groups to be dosed depending on assigned group: control, 1 mg/kg on a soil basis, 10 mg/kg, 100 mg/kg, 1,000 mg/kg, and 10,000 mg/kg.
- Plants were scored every two weeks for the first 24 weeks, and monthly for the rest of the 36 week duration of the experiment.
- Plants were scored as alive or dead to calculate the LD_{50}.

Results

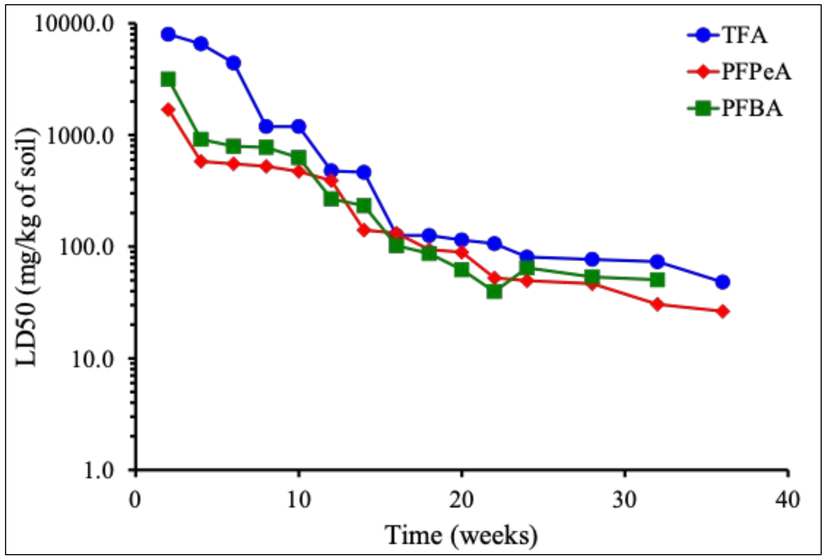

Figure 2. LD_{50} for three different short-chain PFAAs in Joshua Tree seedling as a function of time.

Table 1. Above ground biomass (mean ± SD, mg dry wt.) of surviving Joshua tree seedlings at the end of the experiment.

	Control	1 mg/kg	10 mg/kg	100 mg/kg	1000 mg/kg
TFA	79.1 ± 19.5 (n =26)[a]	106 ± 24.5 (n =19)[c]	89.1 ± 26.6 (n =20)	41.1± 11.6 (n =4)[c]	N.A.[d]
PFPeA	79.1 ± 19.5 (n =26)[a]	70.8 ± 26.8 (n =18)	64.4 ± 22.6 (n =16)[b]	54.4 ± 20.2 (n =7)[b]	N.A.[d]

[a] Control group was the same group for TFA and PFPeA since the experiments were conducted at the same time.

[b] Statistically different from the control group (t-test, P<0.05)

[c] Statistically different from the control group (t-test, P<0.01)

[d] Biomass unavailable as the plants died.

Conclusion

- The shorter the acid chain length, the lower the toxicity is to the Joshua tree seedlings (Fig 2).
- The PFAAs used in this experiment showed increasing toxicity over time presumably due to bioaccumulation.
- Sublethal effects were observed as lowest biomass was seen in the highest dosed plants (Table 1).

Ongoing Research

- The study is ongoing and will analyze the difference in toxicity between C1 and C4 PFAAs.
- Continued research will include the results of toxicity of the chain length in relation to the LD_{50} and variation of impact between xeric species.

Acknowledgements

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References

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[2] Seiber, J. N. & Cahill, T. M. (2021). Trifluoroacetic acid from CFC replacements: An atmospheric toxicant becomes a terrestrial problem. In: *Pesticides, Organic Contaminants, and Pathogens in Air*. [In press]. Taylor & Francis Publishing. Milton Park, Oxfordshire. DOI: 10.1201/9781003217602-9