One Health Research Project Abstract

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Research Abstract:
Per- and poly-fluoroalkyl substances (PFAS) are a group of synthetic organic compounds used in hundreds of industrial applications such as water and non-stick protective coatings, pollution controls, and fire retardants (Zhang et al. 2019). These surfactants are very expensive and difficult to remove in water treatment plants due to their complex chemical compositions of a hydrophobic carbon-fluorine tail and hydrophilic head engineered for specific properties (Vu and Wu 2022). The chains of linked carbon-fluorine atoms exploit the strength of one of the strongest chemical bonds making them some of the most persistent emergent contaminants resistant to degradation (Zhang et al. 2019). These "forever chemicals" have been found in tap water in over 40 states (Andrews and Naidenko 2020). PFAS can accumulate in organisms causing numerous well-documented health issues, including thyroid, heart, and liver diseases, in humans and animals, and phytotoxic effects in plants (Costello and Lee 2020; Li et al. 2022; Vu and Wu 2022; Zhang et al. 2019). Due to their ubiquitous nature, human exposure to PFAS come from everyday products including contaminated water or crops (Lan et al. 2018). Plants are susceptible to PFAS uptake through similar pathways used for nutrient absorption from sources including irrigation water, pesticides, foliar uptake of aeolian deposited PFAS, and root uptake in contaminated soils (Costello and Lee 2020; Li et al. 2022). This uptake mechanism can be utilized for societal benefit when novel bioremediation remediation techniques for PFAS removal are employed in contaminated water.

Artificial wetlands, established with favorable aquatic plants, are a lower cost and easy to maintain management practice for removal of organic chemicals and heavy metals from treated wastewater effluent (Maldonado et al. 2022). Although most engineered wetlands use emergent plants, free floating macrophyte plants are beneficial due to their enhanced absorption capabilities and direct contact with the contaminated water (Maldonado et al. 2022). Azolla (aka mosquito fern or duck weed) is a hardy free floating macrophytes capable of doubling its biomass in 2-5 days and is resistant to many environmental stressors (Gomes et al. 2018, Sood et al. 2012). Studies have demonstrated the efficacy of Azolla for removing heavy metals, radioactive compounds, dyes, and pharmaceuticals (Maldonado et al. 2022), but studies with PFAS are lacking. This proposal will utilize Azolla in a wetland setting to treat PFAS with three specific aims: Aim 1: Evaluate the efficacy of Azolla to remove a suite of 25 PFAS compounds from a lab spiked stock solution, Aim 2: Determine where the PFAS accumulates in tissues via assays of leaves, stems and roots, Aim 3: Use contaminated groundwater from the Central Tucson Project to test Azolla's absorption capabilities with natural water known to contain PFAS.

The proposed experiments follow established macrophyte remediation techniques (Pi et al. 2017). For Aim 1 we will grow Azolla in tanks (e.g. 5 gal buckets) in triplicate with a control tank containing no plants to account for potential PFAS loss to tank walls. Ten Azolla plants will be established in each tank while water is be replenished daily. After the plants have matured for 7 d, the water will be spiked with a stock solution of PFAS to a final concentration 1 ppb for PFAS. Every day an aqueous sample will be collected to measure the any loss of PFAS. For Aim 2, a plant will be randomly chosen and removed to measure PFAS accumulated in each if the different parts. The PFAS tissue analysis follows Taniyasu et al. 2005 and will be done in the Arizona Lab of Emerging Contaminants (ALEC) following their developed technique. Finally, a new set of plants and tanks be established and repeated as above but with Tucson

water to fulfill Aim 3. The total time for the set up and completion of the experiments should be approximately nine months leaving three months to complete a full report.

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