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Short Communication

Uptake and translocation of perfluoroalkyl acids by hydroponically grown lettuce and spinach exposed to spiked solution and treated wastewaters

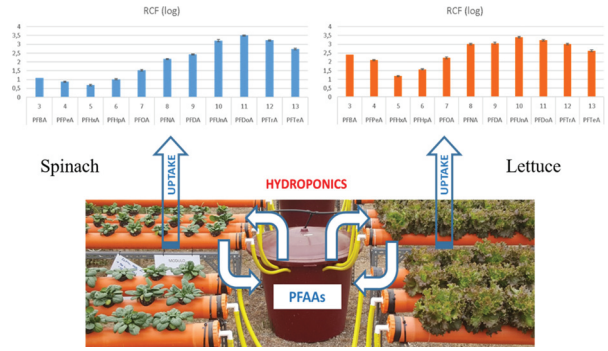
Nicola Dal Ferro [a], Alessandro Pellizzaro [a,b,*], Massimo Fant [b], Mirco Zerlottin [b], Maurizio Borin [a]

[a] Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE), University of Padova, Viale dell'Università 16, 35020 Legnaro, Italy
[b] Acque del Chiampo S.p.A. – Servizio Idrico Integrato, Via Ferraretta 20, 36071 Arzignano, Italy

HIGHLIGHTS

- Crops were exposed to spiked-PFAAs aqueous solution and treated wastewater effluents.
- Higher PFAAs concentration in roots and shoots of lettuce than spinach
- Wastewater PFAAs concentration slightly affected bioconcentration factors
- Sigmoidal pattern of root concentration factor at increasing PFCAs C-chain length
- Translocation factor up to 15 times higher in spinach than lettuce

GRAPHICAL ABSTRACT



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ABSTRACT

Perfluoroalkylated acids (PFAAs) are ubiquitous xenobiotic substances characterized by high persistence, bioaccumulation potential and toxicity, which have attracted global attention due to their widespread presence in both water and biota. In this study, the main objective was to assess PFAAs uptake and accumulation in lettuce (*Lactuca sativa* L.) and spinach (*Spinacia oleracea* L.) when fed with reclaimed wastewaters that are usually discharged onto a surface water body. Lettuce and spinach were grown in hydroponic solutions, exposed to two different municipal wastewater treatment plant (WWTP) effluents and compared with a spiked-PFAAs aqueous solution (nominal concentration of 500 ng L^{-1} for each perfluoroalkyl acid). Eleven perfluoroalkyl carboxylic acids and three perfluoroalkyl sulfonic acids were determined in the hydroponic solution, as well as quantified at the end of the growing cycle in crop roots and shoots. Water and dry plant biomass extracts were analyzed by liquid chromatography-electrospray ionization tandem spectrometry LC-MS/MS technique. The bioconcentration factor of roots (RCF), shoots (LCF), and the root-shoot translocation factor (TF) were quantified. In general, results showed that PFAAs in crop tissues increased at increasing PFAAs water values. Moreover some PFAAs concentrations (especially PFBA, PFBS, PFHxA, PFHpA, PFHxS) were different in both shoots and roots of lettuce and spinach, regardless of the type of water. The long C-chain PFAAs (≥9) were always below the detection threshold in WWTPs effluents. However, when PFAAs were detected, similar bioconcentration parameters were found between crops regardless the type of water. A sigmoidal RCF pattern was found as the perfluorinated chain length increased, plus a linear TF decrease. Comparing bioconcentration factor results with findings of previous studies, lettuce RCF value of PFCAs with perfluorinated chain length ≤ 9 and PFSAs was up to 10 times greater.

* Corresponding author at: Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE), University of Padova, Viale dell'Università 16, 35020 Legnaro, Italy.
E-mail address: pellizzaroa@acquedelchiampospa.it (A. Pellizzaro).

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