Per- and polyfluoroalkyl contamination of irrigation waters in Albania

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Abstract

Albania's agricultural sector plays a significant role in the country's GDP compared to other Western Balkan countries, accounting for 43% of national employment. Approximately 90% of Albania's agricultural exports—a critical contributor to its GDP—are destined for EU member or candidate states. However, according to a recent World Bank report, to fully access these markets, Albania must comply with European food safety and environmental standards.

A major emerging environmental concern is contamination by per- and polyfluoroalkyl substances (PFAS), often referred to as "forever chemicals." These synthetic chemicals form a large and complex class widely used in consumer and industrial products, including pesticides, fire suppressant foams, non-stick cookware, leather treatments, coatings, cleaners, and more. PFAS are persistent in the environment, bio-accumulative, and highly toxic to humans. Currently, the extent of PFAS contamination in Albania's environment is unknown. The objective of this study was to characterize PFAS concentrations in surface and groundwater sources used for agricultural irrigation across Albania.

We collected 77 water samples from multiple locations in Albania, targeting: a) surface water irrigation sources (e.g., rivers, streams, and reservoirs); b) groundwater systems (e.g., wells); and c) waterbodies near industrial sites with potential PFAS discharge. The samples were analyzed using liquid chromatography-tandem mass spectrometry (LC-MS/MS). From a target list of 49 PFAS compounds, 23 specific PFAS were detected in the water samples. Notably, 99% of samples contained detectable PFPrA (C3), while 55% contained PFHxA (C6). Detection rates for other PFAS compounds ranged from 1% to 38%. Total PFAS concentrations were highest in samples from hospital wastewater (2.2×10^6 ppt) and an oil production site (2.3×10^3 ppt). Among irrigation water samples, the highest levels were found in Benja Lake (439 ppt) and two wells in Tirana (283 ppt) and Kuçovë (307 ppt). The elevated PFAS levels in hospital waste and industrial sources were primarily driven by ultra-short-chain PFAS, which are less environmentally persistent compared to long-chain PFAS.

Since the early 2000s, long-chain PFAS have been largely replaced with short-chain alternatives believed to pose less risk to human health and the environment. In contrast, long-chain PFAS compounds such as PFOA (C8) and PFOS (C8)— the most prevalent PFAS in water sources in the United States and other Western countries — were non-detectable in most of our water samples, with only 3%–5% showing low concentrations. This finding may reflect Albania's limited consumption during its communist era, which lasted until the early 1990s, a time when long-chain PFAS were extensively used in developed countries. While the levels of long-chain PFAS suggest minimal concern, caution is warranted given the limited scope of this study. The samples may not capture all potential emission scenarios. Further research is needed to map contamination across other regions of the country.

This pilot study was funded by the Research Expertise from the Academic Diaspora Fellowship (READ) program to strengthen Albania's research infrastructure. Our findings provide a foundational basis for developing PFAS water quality management strategies to address pollution affecting Albania's agricultural sector.

Keyword: PFAS, PFOA, PFOS, irrigation, forever chemicals, agriculture.