Occurrence of 6PPD-quinone in Environmental Waters

6PPD-quinone, a degradation product of the widely used tire rubber antioxidant 6-phenyl-1,3,5-triazine-2,4-dione (6PPD), has recently garnered significant attention due to its environmental prevalence and toxicity. Initially discovered in the late 20th century, 6PPD reacts with ozone and other oxidative agents, leading to the breakdown of the original compound in the environment and formation of 6PPD-quinone.

Toxicity studies have revealed that 6PPD-quinone poses significant risks to aquatic organisms. It is highly toxic to coho salmon (O. kisutch), causing acute mortality at low concentrations (LC50= 0.8 µg/L). The toxicity level has raised substantial concerns about the broader ecological impacts on other fish species and aquatic life. 6PPD-quinone is relatively stable in aqueous environments, leading to its persistence in water bodies. Its hydrophobic nature suggests particulate matter and sediments can adsorb it, potentially leading to long-term environmental contamination and bioaccumulation in aquatic organisms. Preliminary findings led to recognition of 6PPD-quinone as a ubiquitous pollutant in aquatic ecosystems and identification of its link with "urban runoff mortality syndrome".

To assess the environmental occurrence, fate, and transportation of 6PPD-quinone, we developed an analytical method with liquid chromatography-tandem mass spectrometry (LC-MS/MS) in 2021 long before publication of USEPA draft method 1634 in December 2023. Our method allows precise quantification of 6PPD-quinone at concentrations 400x lower than its LC50 value in environmental waters while meeting with QA/QC acceptance criteria of USEPA method.

Here, we present this sensitive, robust, and quick measurement method along with its application to monitor urban runoff. Our preliminary results and occurrence data in the literature indicate that the concentration of 6PPD-quinone may reach at levels higher than its LC50 value for coho salmon especially in regions with high vehicular traffic.

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Egemen Aydin is a highly skilled interdisciplinary scientist with extensive expertise in analytical chemistry and environmental science. With a Ph.D. in Environmental Sciences and Engineering, he specializes in quantitative and non-targeted analysis of organic pollutants, method development, advanced statistical analysis, and data interpretation. He has a proven track record of developing innovative analytical methods for complex matrices like water, soil, sediment, and tissue, managing significant research contracts, and contributing to multiple peer-reviewed publications. His professional experience spans academic and industry roles, showcasing exceptional skills in high-resolution mass spectrometry, laboratory standards compliance, and technical consulting across environmental and chemical analysis domains.