Minimizing Pesticide Residues Using Plasma-Activated Water Generated by a Pin-hole Air Plasma Jet

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ABSTRACT

The presence of pesticide residues in agricultural products is a major concern due to their potential risks to human health and the environment. This study investigates the reduction of pesticide residues using plasma-activated water (PAW) generated by a laboratory-made pin-hole air plasma jet. The physicochemical characterization revealed significant changes in PAW properties with increased plasma discharge time, including a decrease in pH and increases in oxidation-reduction potential (ORP) and electrical conductivity (EC). Optical emission spectroscopy confirmed the presence of nitrogen and oxygen species in the plasma phase, indicating the generation of reactive oxygen and nitrogen species (ROS and RNS). In PAW, nitrate concentrations were quantified using a conductivity detector, and hydrogen peroxide was measured with a hydrogen peroxide assay kit. These reactive species impart strong oxidative properties to PAW, which play a crucial role in pesticide degradation. Optimal PAW parameters were established for effective pesticide removal, and degradation was monitored using high-performance liquid chromatography (HPLC) and liquid chromatography-mass spectrometry (LC-MS). After 25 minutes of treatment, maximum reduction rates of 65–88% were observed for the pesticides. The result demonstrates the high efficacy of PAW generated by pin-hole air plasma jets in degrading pesticides with minimal toxic by-product formation, providing valuable insights into sustainable and environmentally friendly detoxification technologies.

Keywords: PAW/ Pesticide/ Degradation/ Pin-hole air plasma jet/ Reduction