Reductive Degradation of Lindane by Tea Extracts in Aqueous Phase

Chi-Wei Wang (home3021581@hotmail.com) and Chenju Liang (cliang@nchu.edu.tw)
(National Chung Hsing University, Taichung, Taiwan)

Background/Objectives. Persistent organochlorine pesticide (OCP) (e.g., lindane characterized by high lipid solubility and chemically stability, allowing it to bioaccumulate through the food chain) is of great concern in the environment. Tea, one of the most commonly consumed beverage in the world, has been claimed to act as an antioxidant, cytoprotective, antiproliferative, and antimutagenic reagent in fighting cancer diseases, cardiovascular diseases, and diabetes. These properties are based on tea containing rich polyphenolic compounds and make tea being regarded as a natural reducing agent and/or chelating agent. Based on the reductive potential of tea extracts, the present work focused on evaluating tea extracts to degrade lindane in aqueous phase, and the objectives include: (1) to discover suitable tea extracts from four different types of tea including green tea extract (GTE), pouchong tea extract (PTE), ti-kuan yin tea extract (TTE), and black tea extract (BTE) on the basis of antioxidant activity tests; (2) to investigate the potential of tea extracts in the absence or presence of iron salts and minerals at different pHs for reductive degradation of lindane; and (3) to elucidate the reaction mechanism and degradation kinetics of lindane.

Approach/Activities. Laboratory-scale experiments were conducted under controlled conditions. Initial phase of experiments was designed to discover antioxidant activities of GTE, PTE, TTE and BTE and the ORP variations in the reaction system containing different iron salts and minerals with and without the presence of tea extract. In the second phase of experiments, a selected optimum reaction system was examined for lindane degradation and the parameters evaluated included effects of pH and reagent doses. Lindane degradation intermediates were analyzed and reaction pathway was proposed.

Results/Lessons Learned. The GTE/Fe^{2+} system was capable of degrading lindane in solution at the alkaline condition. With the assistance of dissociated hydroxyl groups of catechins in the GTE (i.e., reducing and chelating), the reduction potential of catechins enabled direct reduction of Fe^{3+} or prevention of oxidation of Fe^{2+} at the alkaline condition and maintaining reducing environment with sufficient electron transfer for dechlorinating lindane. Moreover, the lindane degradation efficiencies appeared to be influenced by factors such as pH, GTE, and Fe^{2+} concentrations. The intermediate products of lindane degradation were identified by the GC/MS analysis and the mechanism behind the GTE/Fe^{2+} system degradation of lindane were proposed in light of the degradation products detected. The results of this study may serve for lindane treatment in the soil and groundwater or sediments remediation.