Abstract

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Title

Hydrogen peroxide pre-oxidation of Microcystis aeruginosa and associated organic matter

Description

Oxidation of algae-laden waters using both conventional and advanced oxidants has been widely studied but little attention was given to hydrogen peroxide (H_2O_2) when used alone. In this study, H_2O_2 was used alone to examine its effectiveness as an oxidant for cyanobacterial population and cellular organic matter (COM) control. One toxic strain, *Microcystis aeruginosa* (CS-555/1), was cultivated in the lab and harvested in the stationary phase. Oxidation experiments were conducted both on cells (10^5 cells mL^{-1} diluted in PBS buffer) and COM (diluted to 5 mg L^{-1}). H_2O_2 concentrations up to 20 mg L^{-1} and oxidation times up to seven days were applied. Flow cytometry with propidium iodide staining was used to monitor *M. aeruginosa* cell physical changes, while corresponding COM characteristics were measured using Total Organic Carbon analysis, Excitation-Emission Matrix and Liquid Chromatography – Organic Carbon Detection.

Under low H_2O_2 doses (0.5–2.5 mg L^{-1}), cyanobacterial cells remained healthy until the seventh day, after which more than 97% cells shrank in size and intermediate cells started to emerge with low phycocyanin fluorescence (17% of the average healthy cell fluorescent intensity). In comparison, three-day treatment using 5, 10 and 20 mg L^{-1} H_2O_2 (corresponding CT values of 334, 693 and 1396 mg h L^{-1}) caused more than 73% of cell removal. The cyanobacterial cell removal rate constant was determined empirically to be 0.0373 M^{-1} s^{-1} (R^2=0.72). No cell membrane damage was observed, and negligible DOC release further validated that cell integrity was maintained. H_2O_2 had no significant effect on the oxidation of COM and microcystin. In conclusion, with dosages higher than 5 mg L^{-1} and treatment time longer than three days, H_2O_2 oxidation successfully inactivated and removed most cyanobacterial cells without causing intracellular organic matter leakage. The outcomes of this research can be used to guide water treatment applications of H_2O_2.