EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

CYANOCOST – ES 1105 Action

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Cyanobacterial blooms and toxins in water resources: Occurrence, impacts and management.

Short Term Scientific Mission (STSM)

Evaluation of the efficiency of Advanced Oxidation Processes (AOPs) for the removal of various microcystins (MCs) under realistic conditions

Objectives

The aim of this study was to compare the efficiency of different Advanced Oxidation Processes (AOPs) for the removal of a mixture of cyanotoxins under realistic conditions (MC concentration and water matrix) and to determine which is the most efficient treatment. Three derivatives from the group of microcystins (MC-LR, MC-YR, MC-RR) were chosen as model cyanotoxins because of their frequency of appearance and because studies have shown that a bloom can produce up to 12 different types of cyanotoxins. The study also aimed to identify and quantify the effects of different water parameters have on the removal efficiency of MCs and, were applicable, the percentage of inhibition of each parameter. Bottled water was used to simulate the water matrix under realistic conditions. Since the "Catalytic-Photocatalytic Processes Laboratory (Solar Energy, Environment) and Environmental Analysis Laboratory" of NCSR Demokritos is one of the few facilities in the world that have accredited methods on the detection of microcystins with quantification limit in the ng/L range, it was agreed to perform the experiments there.

Methodology

Initially, an analytical method was developed based on LC/MS/MS (Thermo Finnigan) techniques for the simultaneous analysis of the MCs, along with calibration curves in order to determine the remaining concentration of the toxins in the treated samples. The initial concentration of each MC was 10 μg/L. In addition, pre-tests were performed to determine the experimental conditions of the various AOPs such as oxidant and catalyst concentration and intensity of radiation. Degradation of the MCs mixture was performed in Milli-Q® water with UVC, UVC/H_2O_2 and TiO_2 photocatalysis. The same experiments where repeated in bottled water and in synthetic water that contained the same alkalinity as the bottled water (269.2 mg/L HCO_3^-) and NOM at 1 mg/L and 2 mg/L (as DOC). Control experiments (UVA/NOM, UVA/H_2O_2) as well as dark adsorption experiments (MCs/TiO_2 at concentration 10, 25, 50, 100 mg/L and MCs/NOM) were performed to account for removal of the toxin due to adsorption.

Results

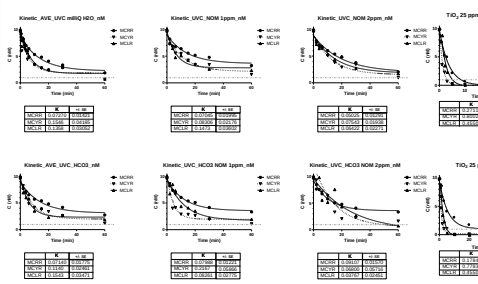

Fig. 1: Degradation of MCs with UVC (LP, λ =254nm). Effects of NOM and alkalinity.

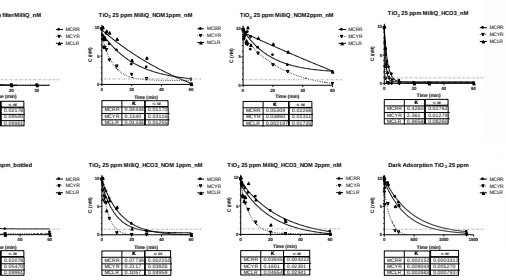

Fig. 2: Degradation of MCs with 25 mg/L TiO_2 (Degussa)/ UVA. Effects of NOM and alkalinity.

Highlights

- Susceptibility of the three MCs towards treatment with the AOPs in the mixture differed.
- NOM affected the efficiency of all the AOPs used and its inhibitory effect increased with increasing concentration.
- Alkalinity had little or no effect on the degradation.
- Dark adsorption experiments with TiO_2 indicated significant removal of MCs via adsorption.
- Overall, our results showed that the water matrix characteristics can affect the efficiency removal of cyanotoxins with AOPs even at these low concentrations.

Researcher

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She has a BSc in Chemistry (University of Cyprus, 2002) and a PhD on Water Quality (University of Cincinnati, 2010). Her work experience includes serving as a Guest Worker at the USEPA in Cincinnati and a postdoctoral fellow at DTU-Environment of the Technical University of Denmark. During her doctoral and postdoctoral tenures she utilized advanced oxidation technologies (AOTs) for the removal of emerging contaminants from water and wastewater. So far, she has authored 16 peer-review publications, 2 book chapters, and received 21 awards.

Host Organization

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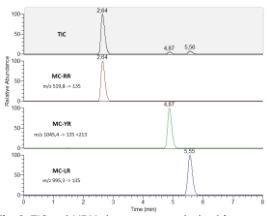

Fig. 3: TIC and MRM chromatograms obtained from standard solution of the three analytes at a concentration of 10 μg L^{-1}

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