Ecotoxicology and Environmental Safety 210 (2021) 111862

Contents lists available at ScienceDirect

Ecotoxicology and Environmental Safety

journal homepage: www.elsevier.com/locate/ecoenv

A novel ternary heterogeneous $TiO_2/BiVO_4$/NaY-Zeolite nanocomposite for photocatalytic degradation of microcystin-leucine arginine (MC-LR) under visible light

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ARTICLE INFO

Edited by Dr G Liu

Keywords:
Microcystin-LR
$BiVO_4/TiO_2$/NaY-Zeolite
Photocatalytic degradation
Visible light
RSM

ABSTRACT

Microcystin-leucine arginine (MC-LR) is a carcinogenic toxin, produced by cyanobacteria. The release of this toxin into drinking water sources can threaten public health and environmental safety. Therefore, effective MC-LR removal from water resources is necessary. In the present study, the hydrothermal method was used to synthesize a novel ternary $BiVO_4/TiO_2$/NaY-Zeolite (B/T/N-Z) nanocomposite for MC-LR degradation under visible light. FESEM, FTIR, XRD, and DRS were performed for characterizing the nanocomposite structure. Also, the Response Surface Methodology (RSM) was applied to determine the impact of catalyst dosage, pH, and contact time on the MC-LR removal. High-performance liquid chromatography was performed to measure the MC-LR concentration. Based on the results, independent parameters, including contact time, catalyst dosage, and pH, significantly affected the MC-LR removal ($P < 0.05$). In other words, increasing the contact time, catalyst dosage, and acidic pH had positive effects on MC-LR removal. Among these variables, the catalyst dosage, with the mean square and F-value of 1041.37 and 162.84, respectively, had the greatest effect on the MC-LR removal efficiency. Apart from the interaction between the catalyst dosage and contact time, the interaction effects of other parameters were not significant. Also, the maximum MC-LR removal efficiency was 99.88% under optimal conditions (contact time = 120 min, catalyst dosage = 1 g/L, and pH = 5). According to the results, the B/T/N-Z nanocomposite, as a novel and effective photocatalyst could be used to degrade MC-LR from polluted water.

1. Introduction

Cyanobacterial harmful blooms (CHBs), which can be found in lakes, dams, and water reservoirs, are recognized as serious health threats. They are strongly dependent on the nutrient and hydrologic conditions of the water body (Zhao et al., 2020). CHBs produce more than 90 variants of cyanotoxins, including microcystin (MC), which is the most notable member of this family. Also, microcystin-leucine arginine (MC-LR), a member of the microcystin group, is recognized as highly toxic microcystin (Zhang et al., 2014; Fuhar et al., 2019). MC-LR is a hepatotoxic and carcinogenic toxin produced by cyanobacteria. The release of this toxin into drinking water sources can threaten public health and environmental safety (Cornish et al., 2000; Zhang et al., 2014; Wen et al., 2019; Massey and Yang, 2020). Acute and chronic exposure to MC-LR can damage the kidney, heart, liver, gastrointestinal tract, and reproductive gland tissues (Nawaz et al., 2018; Zhao et al., 2019). The World Health Organization (WHO) has recommended an MC-LR concentration of 1 μg/L in drinking water due to its toxicity (Antoniou et al., 2018). Therefore, removing MC-LR and other cyanotoxins from water resources, particularly from drinking water resources,

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https://doi.org/10.1016/j.ecoenv.2020.111862
Received 10 September 2020; Received in revised form 19 December 2020; Accepted 23 December 2020
Available online 8 January 2021
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