World Academy of Science, Engineering and Technology
International Journal of Medical and Health Sciences
Vol:17, No:02, 2023

Phytoremediation of Pharmaceutical Emerging Contaminant-Laden Wastewater: A Techno-Economic and Sustainable Development Approach

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Abstract : Pharmaceuticals and personal care products (PPCPs) are a unique group of emerging contaminants continuously introduced into the aquatic ecosystem at concentrations capable of inducing adverse effects on humans and aquatic organisms, even at trace levels ranging from ppt to ppm. Amongst the common pharmaceutical emerging pollutants detected in several aquatic environments, acetaminophen has been recognized for its high toxicity. Once released into the aquatic environment, acetaminophen could be degraded by the microbial community and adsorption/ uptake by the plants. Although many studies have investigated the hazard risks of acetaminophen pollutants on aquatic animals, the number of studies demonstrating its removal efficiency and effects on the aquatic plant still needs to be expanded. In this context, this study aims to apply the aquatic plant-based phytoremediation system to eliminate this emerging contaminant from domestic wastewater. The phytoremediation experiment was performed in a hydroponic system containing Eichhornia crassipes and operated under the natural environment at 25°C to 30°C. This system was subjected to synthetic domestic wastewater with the maximum initial chemical oxygen demand (COD) of 390 mg/L and three different acetaminophen concentrations of 25, 50, and 200 mg/L. After 17 d of operation, the phytoremediation system achieved removal efficiencies of about 100% and 85.6±4.2% for acetaminophen and COD, respectively.Moreover, the Eichhornia crassipes could withstand the toxicity associated with increasing the acetaminophen concentrations from 25 to 200 mg/L. This high treatment performance could be assigned to the well-adaptation of the water hyacinth to the phytoremediation factors. Moreover, it has been proposed that this phytoremediation system could be largely supported by phytodegradation and plant uptaking mechanisms; however, detecting the generated intermediates, metabolites, and degradation products are still under investigation. Applying this free-floating plant in wastewater treatment and reducing emerging contaminants would meet the targets of SDGs 3, 6, and. 14. The cost-benefit analysis was performed for the phytoremediation system. The phytoremediation system is financially viable as the net profit was 2921 US $/ y with a payback period of nine years.

Keywords : domestic wastewater, emerging pollutants, hydrophyte Eichhornia crassipes, paracetamol removal efficiency, sustainable development goals (SDGs)
Conference Title : ICMBS 2023 : International Conference on Medical and Biosciences
Conference Location : Jeddah, Saudi Arabia
Conference Dates : February 20-21, 2023