

Enhanced Pollutant Removal Efficiency in a Long-Term Integrated Constructed Wetland System Using Cork and Date Palm By-Products as Biomaterials

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Abstract : This study investigated the long-term impact of incorporating biowaste (i.e., cork and date stones) as a natural and cost-effective alternative to traditional substrates (e.g. gravel) in constructed wetlands (CWs). Results showed that pollutant removal efficiency was significantly improved after the addition of biowaste under different hydraulic retention time (HRT) conditions. In vertical flow constructed wetlands (VFCWs), the addition of cork improved chemical oxygen demand (COD) removal from 64% to 86%. In horizontal flow constructed wetlands (HFCWs), COD removal increased from 67% to 81% with cork and to 85% with date stones. Ammonium removal was also boosted, with cork in VFCWs increasing efficiency from 34% to 56%. In HFCWs, it improved from 24% to 47% with cork and to 44% with date stones. Furthermore, our data showed that the addition of biowastes improved the removal of micropollutants, such as bisphenol A (BPA) and diclofenac (DFC), with the highest removal rates of BPA (86%) and DFC (89%) observed in the wetland with date stones. However, no significant changes were observed in pathogen removal. Additionally, the incorporation of biowastes reduced the required HRT for efficient pollutant removal, although it did not significantly affect the contribution of plant species. Importantly, this study highlights the dual benefits of using biowaste. On the environmental side, reusing agricultural and industrial residues such as cork and date stones can reduce landfill waste and promotes sustainable waste management. From an economic perspective, these materials offer a cost-effective alternative to traditional substrates and are therefore suitable for wider application in the CWs. These findings highlight the potential of biowaste as a sustainable, efficient solution for wastewater treatment.

Keywords : constructed wetlands, cork, date stones, pollutant removal, wastewater

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