

## Long-Term Treatment Efficiency of an Integrated Constructed Wetland System for the Removal of Pollutants Using Biomaterials/ Cork and Date Palm By-Product

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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. The addition of cork in vertical flow constructed wetlands (VFCWs) improved chemical oxygen demand (COD) removal from 64% to 86%. Similarly, in horizontal flow constructed wetlands (HFCWs), COD removal increased from 67% to 81% with cork and 85% with date seeds. In terms of ammonium removal, cork in VFCWs increased efficiency from 34% to 56%, while in HFCWs, it improved from 24% to 47% with cork and reached 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 of BPA of 86% and DFC of 89% observed in the date seeds wetland. However, no significant changes were observed in pathogens removal. The evaluation of the impact of biowaste addition on the contribution of plant species and its interaction with hydraulic retention time (HRT) was also conducted for pollutant removal. The addition of biowaste resulted in a decrease in the required HRT for effective contaminant elimination, but it had no notable impact on the contribution of plant species. To summarize, our findings indicate that utilizing biowastes in artificial wetlands for the treatment of wastewater with various pollutants can result in synergistic effects, presenting potential benefits in terms of both efficiency and cost-effectiveness.

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

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