Optimization of secondary wastewater treatment with biochar-based vertical-flow wetlands

- **Aims:** Our work has focused on optimizing certain parameters such as the type of biochar, the raw materials, the preparation conditions, the position of the biochar substrate and the percentage (%) of biochar in the substrate in order to improve treatment performance using wetlands constructed with vertical flow.

Second study: Efficiency of Biochar-based columns filter in Wastewater Treatment: Effects of Biochar Type and their Properties.

➢ **The main objective of this study is to test different types of biochar-based filtration systems derived from different biomasses in order to select the appropriate biochar for wastewater treatment.**

Based on the previous **Newsletter 3**:
- The best position of biochar is to place it as an interlayer between two coarse sand layers.
- 10% is an optimal percentage of biochar in the interlayer.

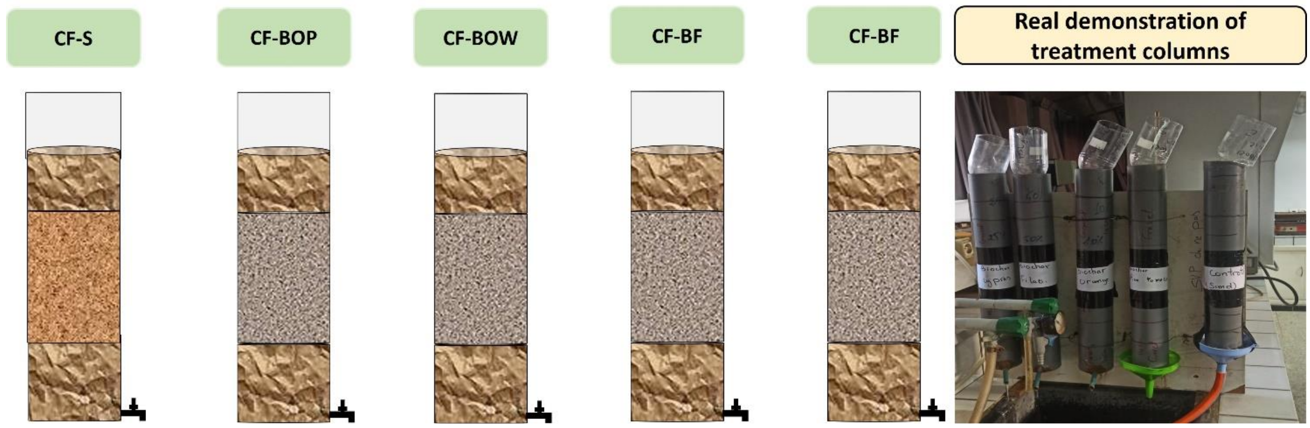

Figure 1 – Experimental device of column filters-based different type of biochars

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- **Experimental**

The experimental set-up was installed in our laboratory at the Department of Biology of the University of Cadi Ayyad (Laboratory of Water, Biodiversity and Climate Change, Faculty of Sciences Semlalia Marrakech).

The wastewater used in these experiments was collected from the primary settling stage of the wastewater treatment plant of Marrakech (Morocco), which treats mixed domestic-textile wastewater.

In this study, the settled wastewater was treated using five column filtration systems (CFSs) based on sand (CFS-S), olive pomace biochar (CFS-OP), orange waste biochar (CFS-OW), filao biochar (CFS-F), and cypress biochar (CFS-C).

The CFSs are 30 cm high, with two gravel layers of 8 cm, one at the top (2–6 mm diameter) and another at the bottom of the filter (2–8 mm diameter) as a drainage layer. The biochar interlayer is 14 cm high with 10%biochar in the coarse sand. The five CFSs consist of polyvinyl chloride (PVC) with an internal diameter of 7.5 cm, a surface area of 0.004 m^2, and a total height of 45 cm each (**Figure 1**).

All CFS were operated in sequential batch filling and emptying mode (3 batches/day), with a total volume of 1 L/day, and an organic loading rate of about 88 g of COD/m^2/day.

Conventional parameters (i.e., pH, electrical conductivity, total suspended solids (TSS), total and dissolved chemical oxygen demand (TCOD; DCOD), TKN, NH_4^+-N, NO_2^--N, NO_3^--N, PT, PO_4^{3-}, SO_4^{2-}, Ca, Mg, and total hardness (TH), as well as absorbances at 254 and 420 nm were weekly determined. In addition, the bacteriological analyses comprised fecal bacteria indicators (total coliforms (TC), fecal coliforms (FC) and fecal streptococci (FS)).

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The biochars used in this study were produced at a temperature of 400 °C, maintained for a residence time of 12 hours with a heating rate of 2 °C/min (orange waste (BOW), filao (BF), and cypress (BC)), except the biochar derived from olive pomace which produced at a temperature of 590 °C and maintained for a residence time of 2h with a heating rate of 10 °C/min.

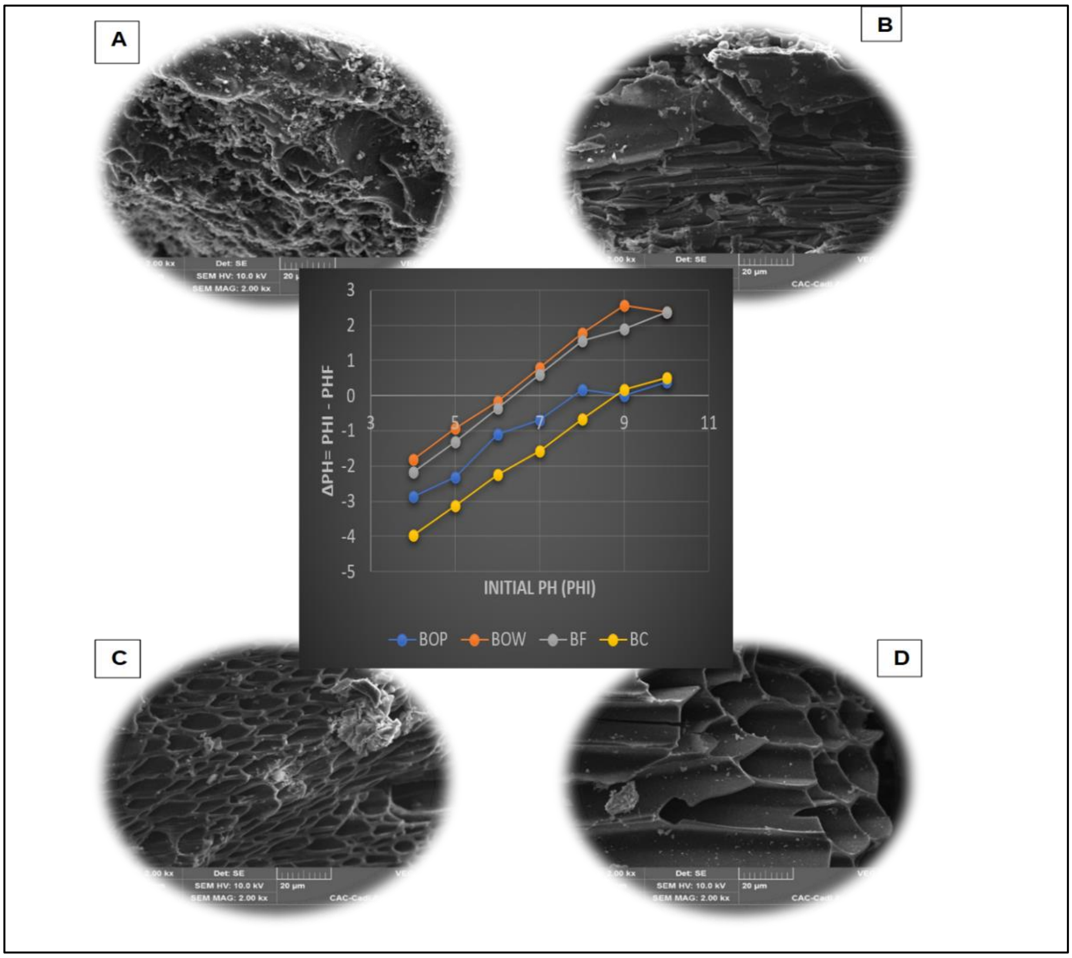

Figure 2 – Superficial characteristics of different type of biochars: BOP (A), BOW (B), BF (C), and BC (D) used in CF.

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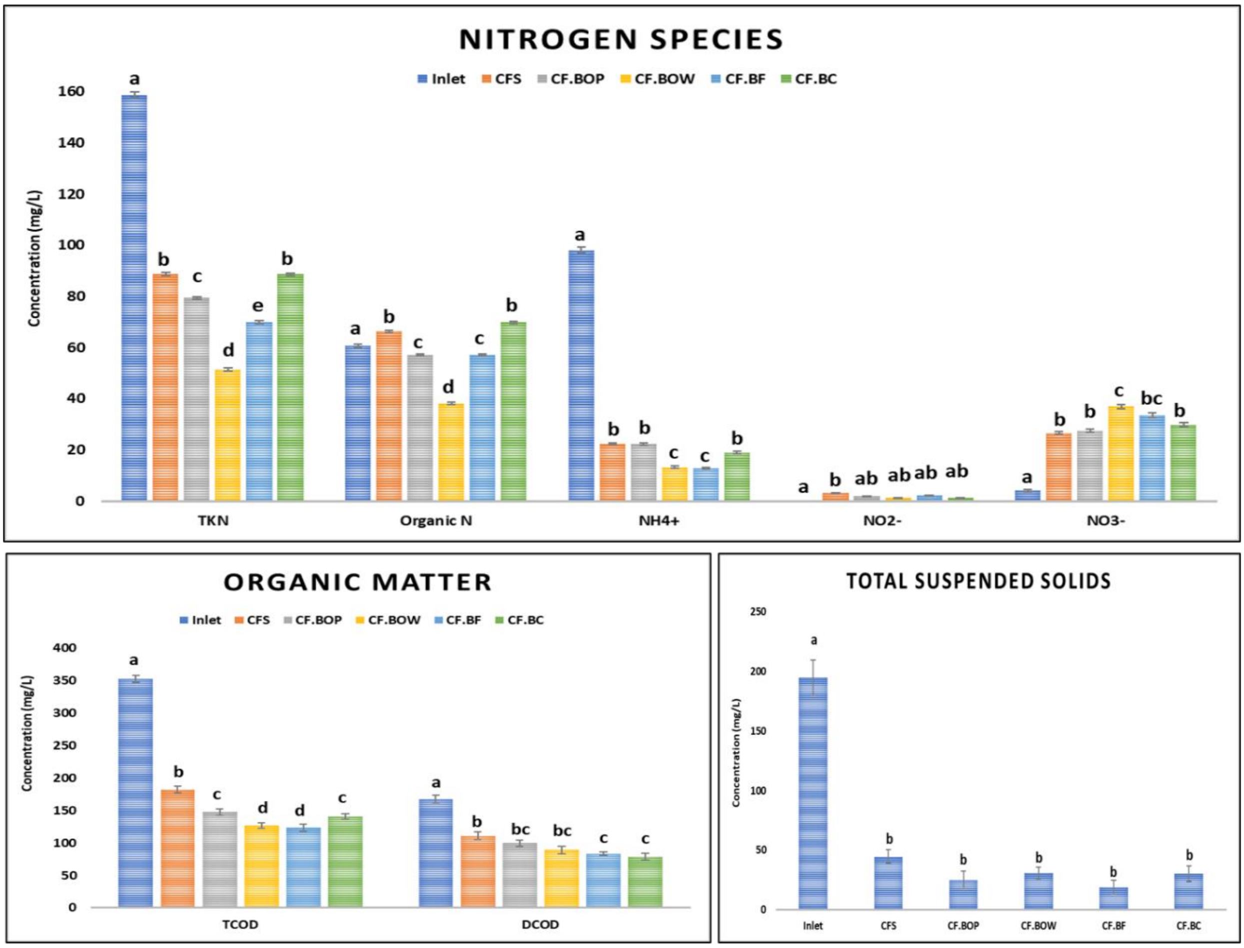

Figure 3 – Overview of the results obtained for conventional parameters

Based on this study:

- The addition of the biochar to sand media showed a significant improvement in removal performance of pollutants in CFS, compared to control sand-based filter.
- CF.BOW showed the best removal results towards almost pollutants, following by CF.BOP and CF.BF.
- Due to the increased availability of olive oil in Morocco, the olive pomace could be a good choice as feedstock for biochar production, making it a viable option for use in full-scale filters and/or CWs.

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