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P.II.5 — Effect of synthesis route of Mg-modified biochar from lignocellulosic residues for adsorption of nitrate in aqueous phase

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Poster Presentations #31

P.II.5 — Effect of synthesis route of Mg-modified biochar from lignocellulosic residues for adsorption of nitrate in aqueous phase

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The increasing presence of nitrogen and phosphorus compounds in wastewater poses a significant challenge for treatment processes and sustainable water resource management. In this context, electroadsorption processes using biochar and biochar-based electrodes derived from lignocellulosic residues emerge as a promising alternative.

Adsorbents were synthesized from pine residues and walnut shells using $MgCl_2$ and $MgCO_3$ as modifying agents. Two different synthesis routes were evaluated: (i) direct impregnation followed by thermal treatment (500–700 ºC) under an inert atmosphere, and (ii) a sequential treatment consisting of a N_2 pyrolysis at 500 ºC, followed by impregnation and subsequent thermal activation at 800 ºC under an inert atmosphere (N_2). The activating agent-to-biomass ratio ranged from 0.5:1 to 1.5:1. The resulting materials were characterized by ICP, N_2 adsorption–desorption isotherms, and TGA. The analyses confirmed the effective incorporation of Mg, the development of microporosity, and an ash content between 9.9 and 23.9 wt.%, indicating the presence of mineral species in the biochar.

The functionality of the materials was evaluated through batch adsorption experiments (24 h, 25 ºC, 180 rpm) using synthetic nitrate solutions (KNO_3) at initial concentrations of 50 and 100 mg NO_3^-/L. The first synthesis route did not show the expected performance, exhibiting negligible adsorption capacity. In contrast, the sequential route proved to be effective with the three biochars prepared from pine residues using an activating agent-to-biomass ratio of 0.5: $MgCl_2$-impregnated biochar (P_$MgCl_2$), $MgCO_3$-modified biochar (P_$MgCO_3$), and a non-modified reference biochar (P) (Figure 1).

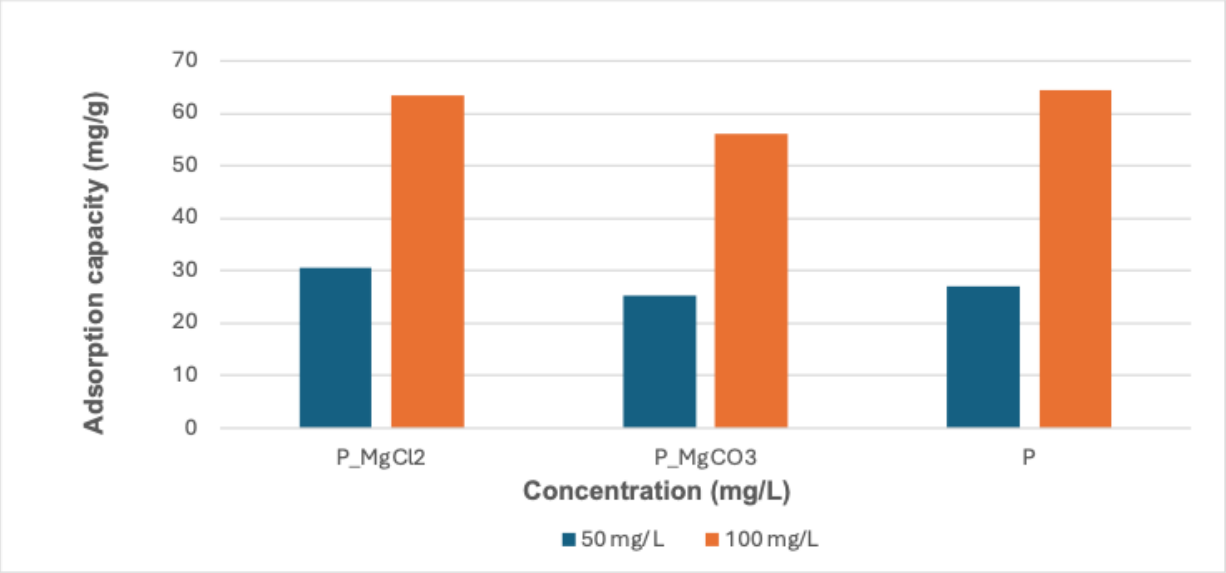


Figure 1. Adsorption capacity.

These results indicate that nitrate adsorption is not solely governed by Mg incorporation or ash content, but rather by the accessibility of active sites and the structural properties of the biochar. Although $MgCl_2$-

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modified biochar showed slightly better performance at lower concentration, the non-modified biochar exhibited comparable results at higher concentration, while the use of $MgCO_3$ precursor consistently showed lower adsorption capacity.

These findings demonstrate that optimizing synthesis and activation conditions is crucial for enhancing material performance. Furthermore, they highlight the potential of biochar derived from lignocellulosic waste as a sustainable, efficient, and low-cost solution for wastewater treatment.

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