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Phosphorous recovery from treated wastewater by salt activated biochar

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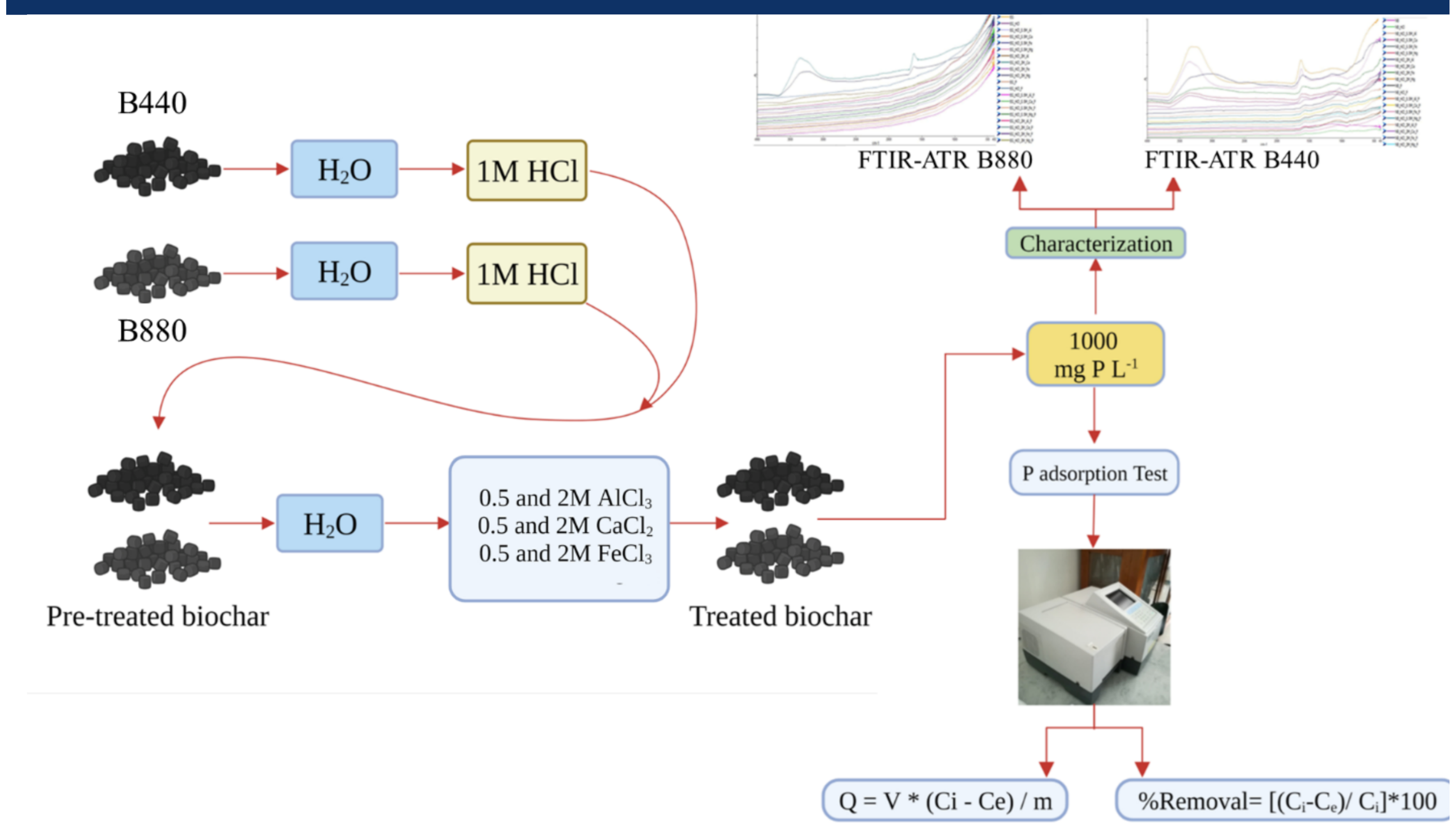
INTRODUCTION

Phosphorus (P), a non-renewable resource, is an essential element for life and an irreplaceable component of modern agriculture [1]. Since it is a non-renewable resource, a more rational use of P fertilisers and its recovery from wastes are desiderable [2]. P can be recovered from aqueous solution, such as urban, industrial and agricultural wastewater, by its sorption onto a solid phase.
Biochar is among the most widely used solid materials for nutrient recovery. Studies have shown that biochar can be modified to improve its P sorption capacity.

AIM OF THE WORK

The purpose of this study was to assess the ability of biochar obtained by the same feedstock at two different pyrolysis temperatures (440 and 880℃), previously modified by HCl solution, and then activated with calcium, iron and aluminium chloride salt solutions at different concentrations (0.5 and 2.0M), in removing P from aqueous solution.

MATERIALS & METHODS



RESULTS

The treatment with HCl affected the ability of biochar in absorbing P differently. From one hand, it worsened the P adsorption capacity of B440 whereas, on the other hand, improved that of B880 (Fig.1 A and B). Following the activation with metal chloride salt solutions, biochar behaves in a similar way. P adsorption ability was greater following the activation with 2.0M salt solution than with 0.5M due to the highest metal absorption onto biochar with the former treatment (Fig.1 A and B). The ability of metals in improving the absorption ability of biochar was dependent by the concentration: at the lowest concentration, the activation with Al salt solution improved P adsorption ability of biochar more than the other solutions whereas, at the highest concentration, it was the Ca salt solution (Fig.1 A and B).

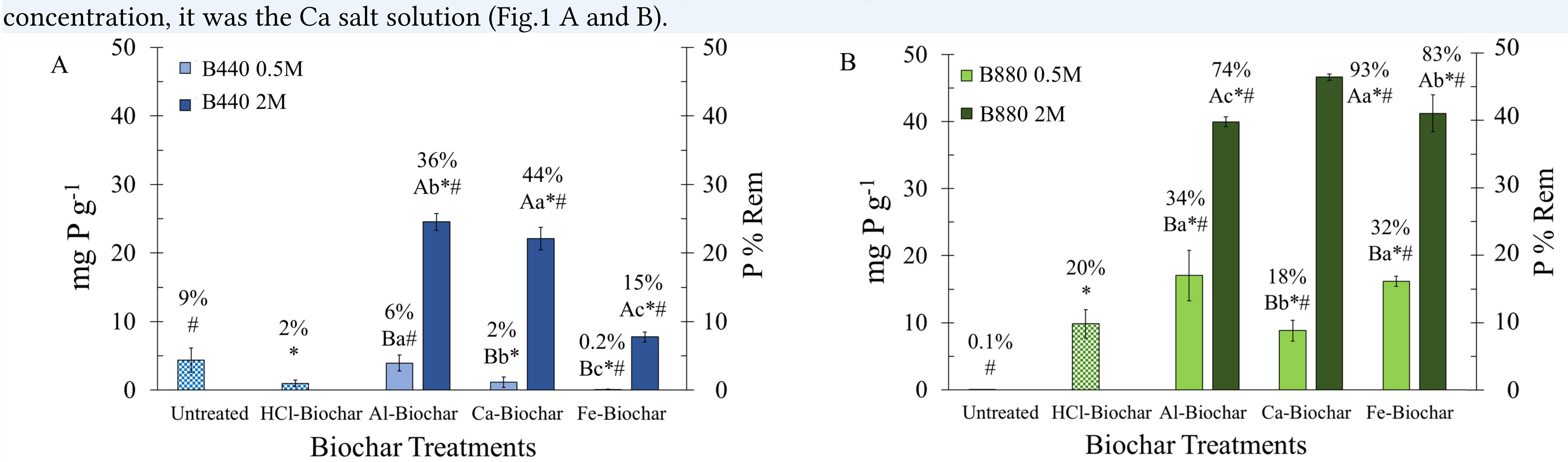


Fig. 1 P Absorption capacity of B440 (A) and B880 (B) biochars treated with different salts and conc. Treatments are: untreated EG biochar (Untreated), EG biochar pre-treated with HCl 1M (HCl-Biochar), EG biochar treated with $AlCl_3$ (Al-Biochar), EG biochar treated with $CaCl_2$ (Ca-Biochar) and EG biochar treated with $FeCl_3$ (Fe-Biochar). Values are mean ± standard deviation of three replicates.

The ATR-FTIR spectra of B440 activated confirmed the P absorption ability of biochar as suggested by absorbance changes in the wavelength regions from 1260 and 1020 cm^{-1} that could be assigned to the stretching vibration of hydrogen-bonded P=O groups of phosphates or polyphosphates, to the O−C stretching vibration in the P−O-C (aromatic) linkage, and to P=OOH (Fig. 2 and 3) [3].
Absorbance changes in the wavelength regions from 1100 and 1050 cm^{-1} (Fig. 2 and 3) also confirmed P absorption by activated B880. Such changes have been assigned to the symmetric stretching vibration of PO_2 or the asymmetric stretching vibration of P-$(OH)_2$ in phosphate. Moreover, peaks may be due to aliphatic P−O−C stretching, aromatic P−O−C asymmetric stretching, P−O stretching in >P=OOH, P−OH bending and P−O−P asymmetric stretching in polyphosphates [3,4].

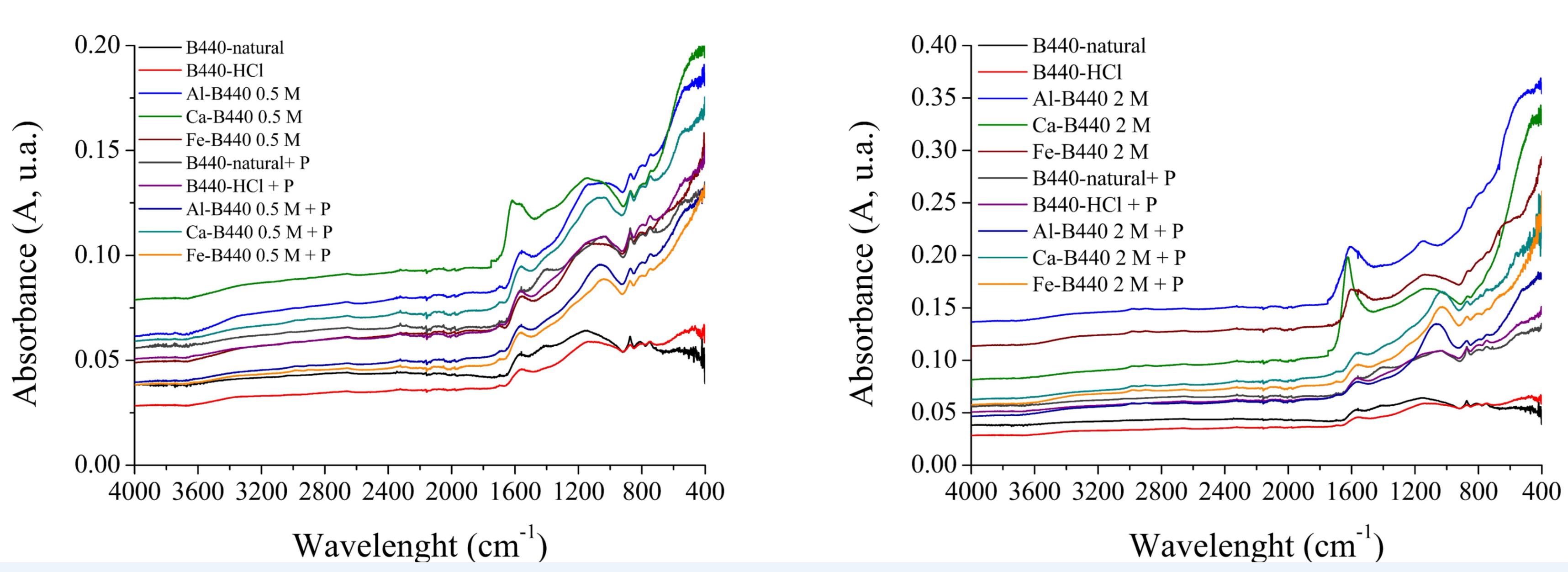


Fig. 2. ATR-FTIR spectra of B440 within the 4000-400 cm^{-1} wavenumber.

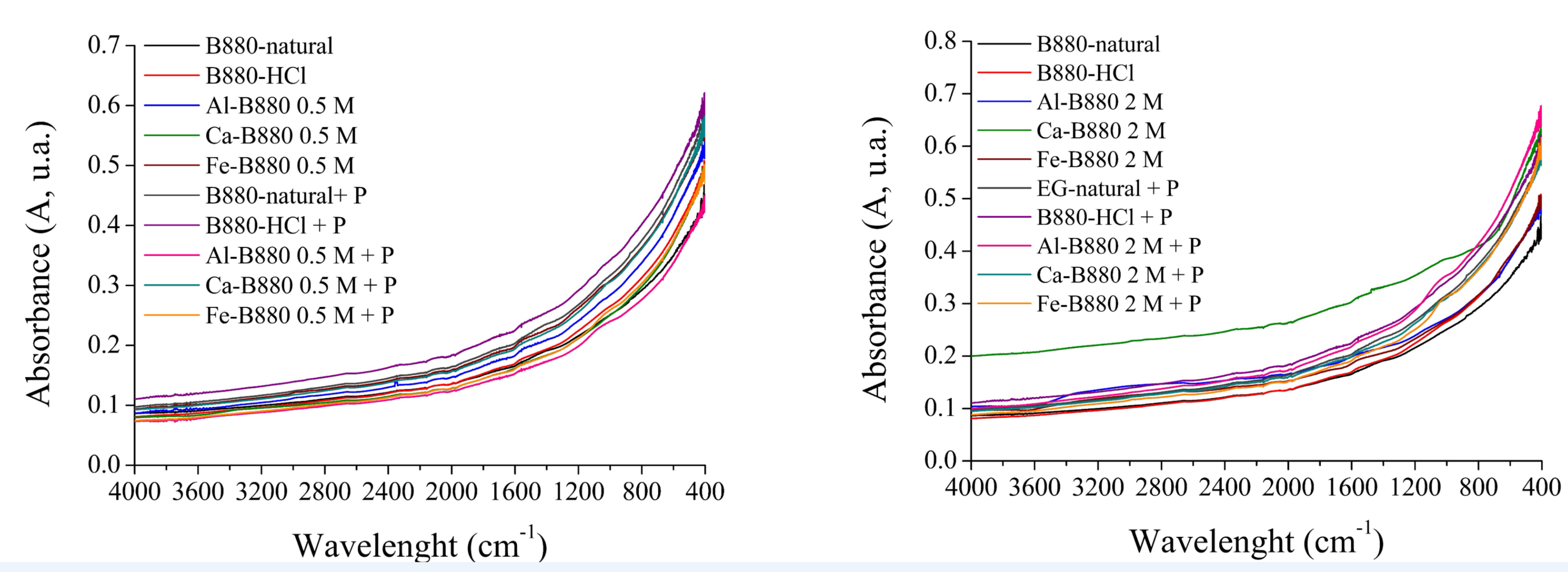


Fig. 3. ATR-FTIR spectra of B880 within the 4000-400 cm^{-1} wavenumber.

CONCLUSIONS

- Treatment with chloride salt solutions increase biochar ability to absorb P.
- The higher the concentration of salt solution, the greater the P absorption capacity of biochar.
- Changes of biochar characteristics following treatment with HCl needs further investigation

ACKNOWLEDGEMENT

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