Application of biochar from crop residues for the removal of lead and copper

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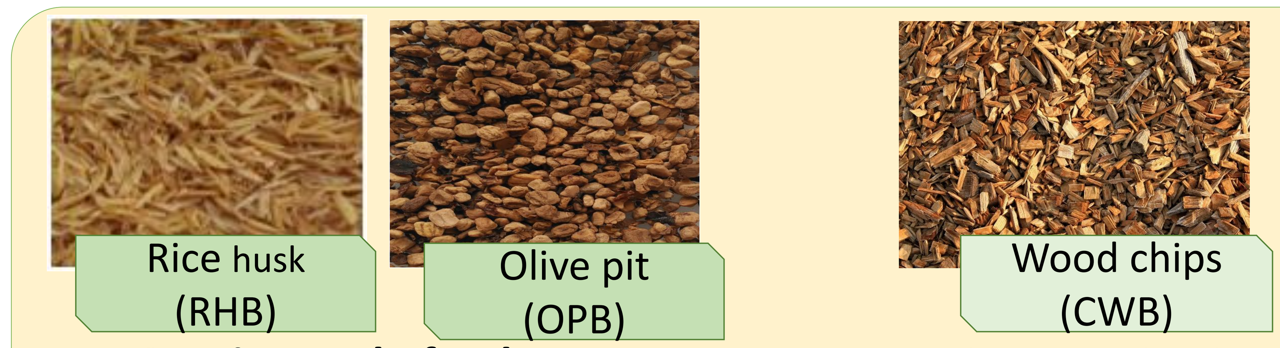
INTRODUCTION

Due to the chemical composition and surface properties of biochar, a C-rich porous material produced by pyrolysis of biomass, it can act as an effective tool for the remediation of soils polluted with trace elements [1, 2]. However, its capacity to sorb these contaminants in a solution varies considerably depend on pyrolysis conditions, but also on the feedstock. Biochar properties vary with feedstock, pyrolysis temperature and time of pyrolysis [3].

Objective: to evaluate the capacity of biochars from two crop residues to sorb Pb^{2+} and Cu^{2+}.

MATERIALS AND METHODS



Continuously feed reactor

Pyreka reactor
500 °C
12 min
N_2 flux

Certified wood biochar produced by Swiss Biochar
620 °C
20 min
No inert gas

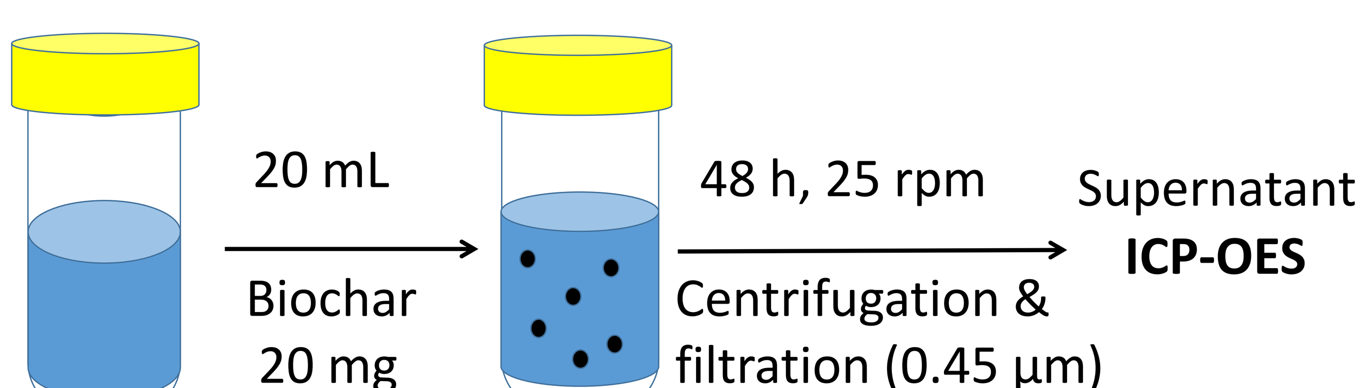
1. Biochar characterization

- Elemental composition
- pH, Water Holding Capacity (WHC)
- SSA-BET, iodine number, total acid and basid sites
- FT-IR, ^{13}C-NMR

2. Batch adsorption experiments

Initial conc. Cu^{2+}/Pb^{2+}:

0.05, 0.1, 0.5,
1, 2 and 5 mM



RESULTS

Table 1. Elemental analysis and ash content (%) of biochars.

	TC (%)	TH (%)	TN (%)	O (%)	H/C_{at}	O/C_{at}	C/N	Ash content (%)
CWB	**75.7**±0.3	1.80±0.02	0.30± 0.06	18.7	0.3	**0.19**	252	3.5 ± 0.7
RHB	53.7±0.1	1.61±0.02	0.51±0.24	9.48	0.4	**0.13**	106	**34.7** ± 0.5
OPB	**92.7**±0.2	2.52±0.06	0.16±0.09	3.58	0.3	0.03	585	1.0 ± 0.3

Table 2. Physical and chemical characteristics and Surface properties of biochars.

	pH	WHC (%)	SSA-BET (CO_2, $m^2\,g^{-1}$)	Iodine Index	Total basicity (meq g^{-1})	Total acidity (meq g^{-1})
CWB	9.95 ± 0.18	243 ± 39	**403**	149	**0.95**	**1.69**
RHB	10.10 ± 0.01	**595** ± 22	292	**180**	**0.51**	**1.70**
OPB	9.34 ± 0.09	70 ± 13	**473**	123	0.05	0.17

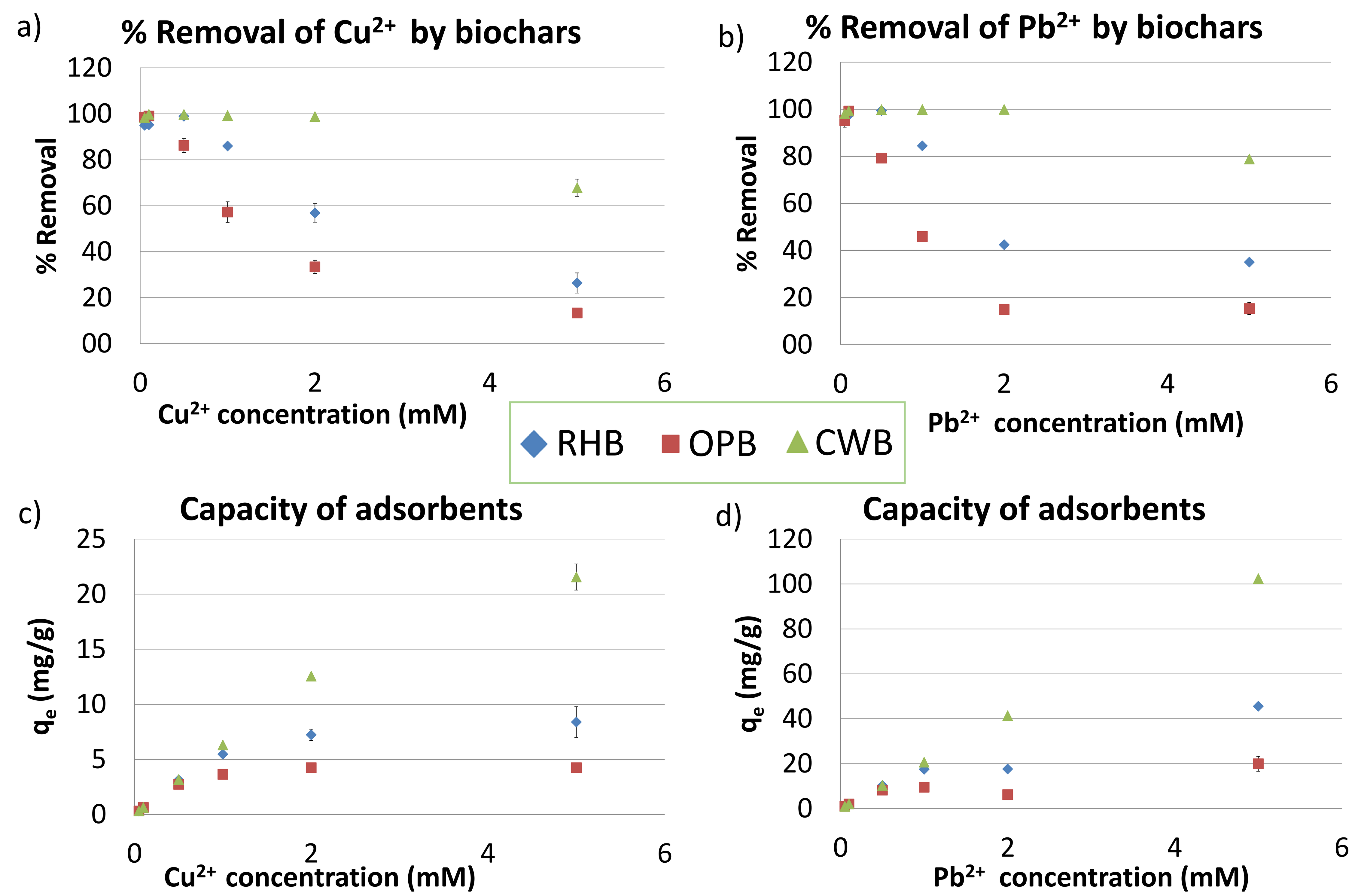


Figure 2. % of removal of Cu^{2+} and Pb^{2+} by biochars (a and b) and capacity of adsorbents (c and d).

- TC > 50 % for all biochars. Biochars showed high aromaticity.
- Greater SSA-BET measured with CO_2 for OPB and CWB than RHB.
- Greater basic and acid sites for RHB and CWB than OPB.
- % Removal of the studied cations in the following order: CWB>RHB>OPB.
- Langmuir isotherm fitted well for RHB and CWB for both cations.
- Temkin and Freundlich fitted Cu^{2+} and Pb^{2+} adsorption for OPB, respectively.

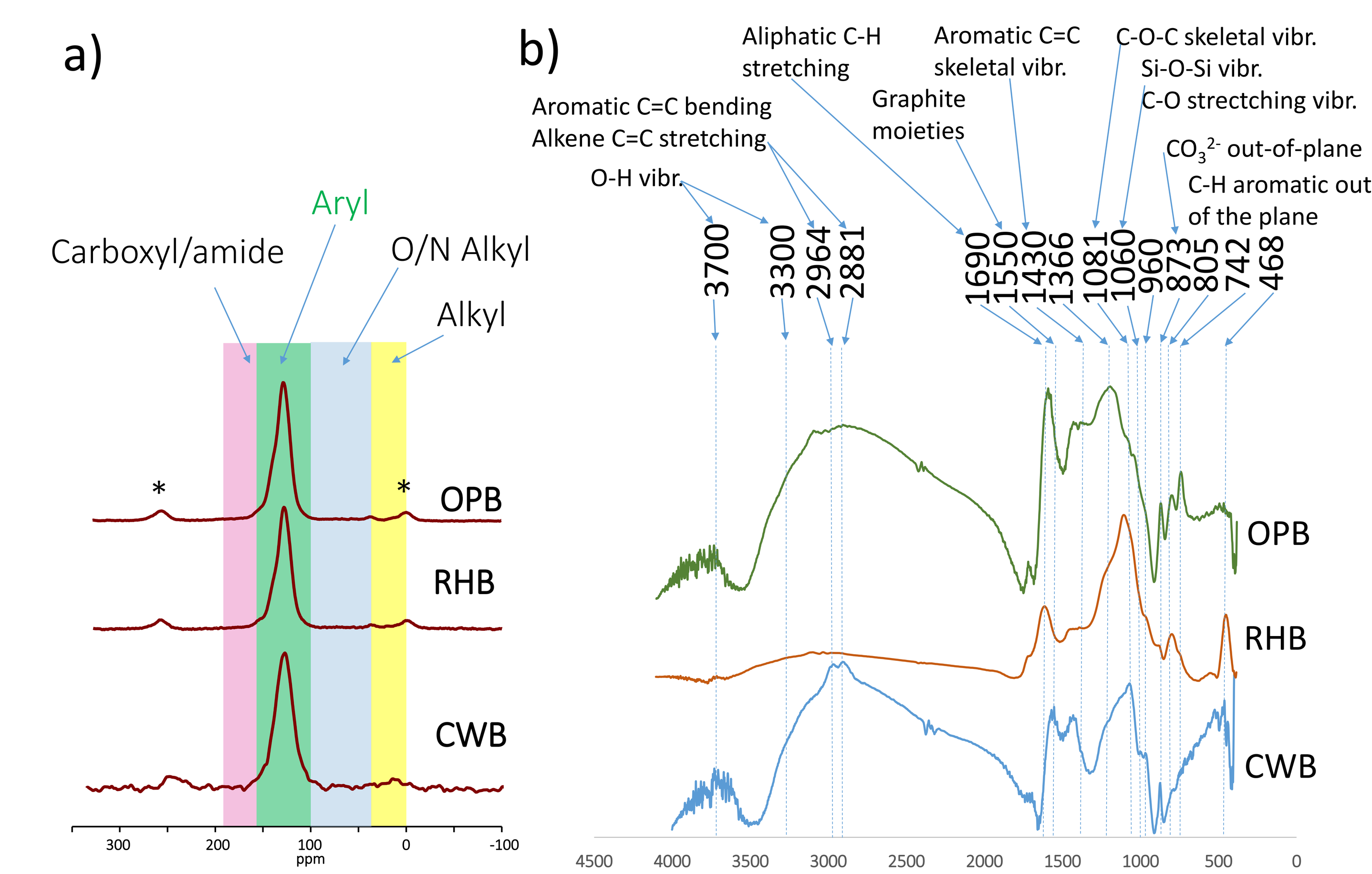


Figure 1. ^{13}C-NMR (a) and FT-IR (b) spectra of the studied biochars. (*) Spinning size bands.

CONCLUSIONS

- High SSA-BET was not related with high adsorption capacity of the biochars. It may be more related to the total acidity.
- CWB, followed by RHB, showed the greatest capacity for adsorption of Cu^{2+} and Pb^{2+}.
- OPB showed the greatest SSA-BET, whereas it also showed the lowest % of removal for both cations. OPB showed few acid sites (only 0.17 meq g^{-1}), related with low oxygen content and very low O/C_{at} ratio.
- Langmuir model well fitted data of RHB and CWB, whereas Freundlich and Temkin fitted better adsorption data in OPB.

References:

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Acknowledgements:

The former Spanish Ministry of Economy, Industry and Competitiveness (MINEICO) and AEI/FEDER are thanked for funding the projects CGL2016-76498-R and CGL2015-64811-P. MINEICO is also thanked for funding the "Ramón y Cajal" post-doctoral contract of José M. De la Rosa. P. Campos thanks the "Fundación Tatiana Pérez de Guzmán el Bueno" for funding her PhD.