Application of biochar from crop residues for the removal of lead and copper
José M. De la Rosa1, Águeda Sánchez-Martín1, María L. Sánchez-Martín1, Nikolas Hagemann2,3, Heike Knicker1, and Paloma Campos1*
(1) Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC), Reina Mercedes 10, 41012, Seville, Spain, (2) Agroscope Zurich, Reckenholzstr. 191, Zurich, Switzerland, (3) Ithaka Institute, Arbaz, Switzerland.
* pcampos@irnas.csic.es

INTRODUCTION
Due to the chemical composition and surface properties of biochar, a 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 depending 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 Pb2+ and Cu2+.

MATERIALS AND METHODS

1. Biochar characterization
• Elemental composition
• pH, Water Holding Capacity (WHC)
• SSA-BET, iodine number, total acid and basic sites
• FT-IR, H2-NMR

2. Batch adsorption experiments
Initial conc. Cu2+/Pb2+: 0.05, 0.1, 0.5, 1, 2 and 5 mM

RESULTS

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

<table>
<thead>
<tr>
<th>Biochar</th>
<th>TC (%)</th>
<th>TH (%)</th>
<th>TN (%)</th>
<th>O (%)</th>
<th>H/C</th>
<th>O/C</th>
<th>C/N</th>
<th>Ash content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWB</td>
<td>75.7±0.3</td>
<td>1.80±0.02</td>
<td>0.30±0.06</td>
<td>18.7</td>
<td>0.3</td>
<td>0.19</td>
<td>252</td>
<td>3.5±0.7</td>
</tr>
<tr>
<td>RHB</td>
<td>53.7±0.1</td>
<td>1.61±0.02</td>
<td>0.51±0.24</td>
<td>9.48</td>
<td>0.4</td>
<td>0.13</td>
<td>106</td>
<td>34.7±0.5</td>
</tr>
<tr>
<td>OPB</td>
<td>92.7±0.2</td>
<td>2.52±0.06</td>
<td>0.16±0.09</td>
<td>3.58</td>
<td>0.3</td>
<td>0.03</td>
<td>585</td>
<td>1.0±0.3</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Biochar</th>
<th>pH</th>
<th>WHC (%)</th>
<th>SSA-BET (CO2, m2 g−1)</th>
<th>Iodine Index</th>
<th>Total basicity (meq g−1)</th>
<th>Total acidity (meq g−1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWB</td>
<td>9.95±0.18</td>
<td>243±39</td>
<td>403</td>
<td>149</td>
<td>0.95</td>
<td>1.69</td>
</tr>
<tr>
<td>RHB</td>
<td>10.10±0.01</td>
<td>595±22</td>
<td>292</td>
<td>180</td>
<td>0.51</td>
<td>1.70</td>
</tr>
<tr>
<td>OPB</td>
<td>9.34±0.09</td>
<td>70±13</td>
<td>473</td>
<td>123</td>
<td>0.05</td>
<td>0.17</td>
</tr>
</tbody>
</table>

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

CONCLUSIONS

• TC > 50 % for all biochars. Biochars showed high amphotericity.
• Greater SSA-BET measured with CO2 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 Cu2+ and Pb2+ adsorption for OPB, respectively.

References:

Acknowledgments:
The former Spanish Ministry of Economy, Industry and Competitiveness (MINEICO) and AEI/FEDER are thanked for funding the projects GI2016-76498-R and GI2015-64811-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.