Biochar Obtained from Different Wood Trunk Layers Allow to Stabilize Pb and As in a Mining Technosol

Simon Chevolleau¹, Florent Beaumont¹, Florie Miard¹, Manhattan Lebrun¹, Romain Nandillon¹, Pascale Gautret², Jean-Christophe Léger³, Sylvain Bourgerie¹, Domenico Morabito¹

¹University of Orleans, INRA USC1328, LBLGC EA 1207
rue de Chartres, BP 6759, 45067, Orléans Cedex 2, France
simon.chevolleau@etu.univ-orleans.fr; florent.beaumont@etu.univ-orleans.fr; florie.miard@univ-orleans.fr; manhattan.lebrun@etu.univ-orleans.fr; romain.nandillon@iddea-ingenierie.fr; sylvain.bourgerie@univ-orleans.fr; domenico.morabito@univ-orleans.fr

²Université d'Orléans, CNRS, BRGM, ISTO, UMR7327
45071 Orléans, France
pascale.gautret@cnrs-orleans.fr

³La Carbonerie
5 rue de la mare, 71530 Crissey, France
jcleger@lacarbonerie.eu

Extended Abstract

Mining activities lead to widespread environmental pollution due to the presence of metal(l)oid)s in tailings. These contaminated areas present a health risk and hence need to be rehabilitated. Ex situ methods for soil remediation have been used for a long time but are expensive and disruptive to soil. Phytoremediation techniques for the stabilization or extraction of metal(l)oid)s could be an efficient alternative as they provide a low-cost and environmentally friendly option. However, due to the often poor nutrient content of these contaminated soils, amendments must be added to enhance plant growth and to improve phytoremediation efficiency. Biochar, a pyrogenic product, is a promising amendment for assisted phytoremediation. It has been demonstrated as a potential candidate for the remediation of metal(l)oid)s contaminated soils [1]. However, the mechanisms of contaminant–biochar retention and release depend on the amount of soil contaminants and physicochemical characteristics, as well as the durability of the biochar contaminant complex, which may be related to the pyrolysis process parameters and the biomass feedstocks. The objective of the present study was to evaluate, in a former contaminated mining site Pontgibaud (France) [2] presenting no vegetation cover and contaminated by high concentration levels of lead (11453 mg.kg⁻¹) and arsenic (539 mg.kg⁻¹), the capacity of three biochar feedstocks (La Carbonerie, France) obtained from different Quercus wood trunk layers (bark, sapwood and heartwood) to significantly reduce lead and arsenic content in soil pore water. The biochars were applied at 2% and presented three different granulometry (0.2 to 0.4 mm, 0.5 to 1 mm and 1 to 2.5 mm). The main physicochemical parameters of biochars and the Pb and As contents in soil pore water were determined during the time course of a phytotoxicity test realized on Phaseolus vulgaris germinations. The growth, the dry weight and the metal contents were analyzed at the end of the experiment in the different organs of the plantlets. Results showed that the addition of the three biochar improved soil conditions by increasing soil pH, electrical conductivity and water holding capacity. Furthermore, the application of the 3 biochars to Pontgibaud technosol reduced significantly Pb and As mobility and availability and allowed plant growth in a technosol where no plants were previously growing. In conclusion, the data clearly demonstrated that biochar application can be effectively used for Pb and As soil immobilization, thereby reducing their bioavailability. Moreover we demonstrate for the first time the capacity of a biochar obtained from bark feedstock to totally stabilize Pb and As in soil allowing no metal(l)oid)s to be detected in soil pore water. These results are very encouraging as to the possibility of using biochar as an amendment to reconquer abandoned areas due to significant soil metal(l)oid)s concentrations.
References
