Abstract:

Biochar (BC) is widely utilized as suitable soil heavy metals (HMs) remediation option, as it shown a tendency to retain the HMs on BC surface; however, the efficacy of BC can be enhanced by adding various functional groups on its surface through organic composites. This dissertation aims to unravel the roles of organic compounds enriched biochars (OCEBs) in trace HMs immobilization in aqueous and soil systems. In the batch sorption experiment, seventeen different treatments having simple rice husk biochar (SBC) and four organic compounds such as glycine, alanine, citric acid and oxalic acid at two molarities (0.01M and 0.05 M) were prepared and applied in an aqueous medium to evaluate the performance in removing the four trace HMs namely copper, nickel, lead and chromium. The results revealed that 0.05M of glycine enriched biochar (GBC), alanine enriched biochar (ABC), citric acid enriched biochar (CABC) and oxalic acid enriched biochar (OABC) showed best performance against Cu and Ni adsorption in the 24 hours batch sorption experiment. The selected BCs were then subjected to Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and electrical conductivity (EC) analysis to observe the change in BC properties before and after modification. The results confirmed that after modification, there was a visible change in the GBC and ABC surface and the FTIR peaks were also sharp in these two BCs. Then, tomato plants were grown in a pot experiment with 21 treatments having GBC and ABC along with simple biochar (SBC). There were two rates of each BC (0.1 and 0.5% w/w) and the rate of Cu and Ni stresses were 150 mg Kg^{-1}. The results

revealed that overall, 0.5% GBC and ABC showed significant improvement in most plant's physiological and biochemical parameters in comparison to the 1% GBC and ABC HM stress. In the next experiment, a hydroponic setup was established to observe the impact of 0.5% GBC and ABC on the tomato root morphology, its amino acid profiling under Cu and Ni stress. The results confirmed that 0.5% GBC was excellent in immobilizing the trace HMs (Ni and Cu). The root methionine concentration enhanced under 0.5%GBC+Ni treatment by 13 folds in comparison to the sole application of Ni stress in tomato plant. Finally, a pot experiment having 9 treatments with three replicates was conducted to reaffirm the hydroponic experiment in soil conditions. This study suggests that organic enrichment of biochar is an excellent option for immobilization of HMs from soil. The addition of 0.5%GBC+Cu significantly enhanced the total root protein concentration by 34% than control treatment. The exposure of Cu stress to the tomato plant significantly decreased the root peroxidase concentration by 57% in comparison to the control treatment. Moreover, to

support the field application of OCEBs, future studies need to deal with the factors linked to metal removal efficiency, like amount of OCEBs dose, pH, regeneration and recovery approaches and disposal of metal sorbed OCEBs.