SLUDGE TRANSFORMS INTO BIOCHAR: DOPING CALCIUM INDUCES PHOSPHORUS TRANSFORMING INTO A PLANT-AVAILABLE SPECIATION

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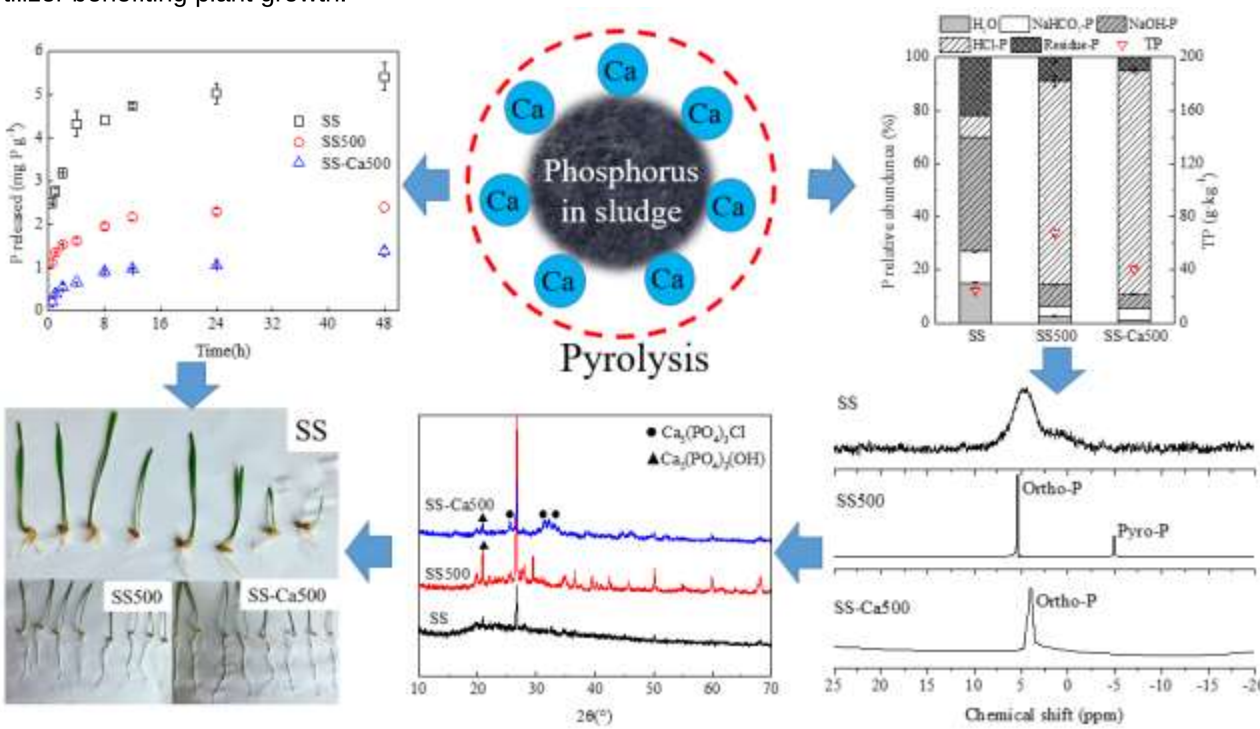
The mass-produced sewage sludge (SS) worldwide is regarded as an important phosphorus (P) pool with a P-content of 2-3% (dry basis). Pyrolytic conversion of SS into P-rich biochar has multiple environmental benefits: toxicity elimination, carbon sequestration and soil fertilization. It has been proved that P transforms into insoluble speciation such as $Ca_2P_2O_7$ during pyrolysis, and this would be influenced significantly by inherent minerals such as Ca, Mg, Fe, Al, etc [1, 2]. With a purpose of enhancing biochar's fertilizer efficiency to plant, we selected calcium (Ca) as an additive to SS and expected their thermal-chemical interaction would induce P transforming into a plant-available speciation. The sequential extraction experiments showed that after pyrolysis (biochar: SS500) the percent of the insoluble phosphates (HCl-extracted P) increased significantly from 8.28% to 76.6%, while the readily soluble P species being extracted by water, $NaHCO_3$ and NaOH decreased sharply. Doping $CaCl_2$ strengthened this transformation and the produced biochars at pyrolysis temperature of 500°C with 20% (w/w) Ca-doping (biochar: SS-Ca500) contained 84.1% insoluble phosphates and 5.28% Fe/Al mineral adsorbed P (NaOH-extracted P). It indicated that Ca could compete for more P than Fe/Al during pyrolysis. Instrumental analysis (XRD, NMR) showed that Ca promoted more formation of pyrophosphate and short-chain polyphosphates such as $Ca_5(PO_4)_3(OH)$, $Ca_5(PO_4)_3Cl$, which are species facilitating plant-uptake while avoiding dissolution loss. This study gave an insight into P speciation transformation during biochar formation and suggested that P availability in biochars are controllable by doping minerals to structure a safe slow-release P fertilizer benefiting plant growth.



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