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An interesting biochar effect that suppressed dechlorination of pentachlorophenol while promoted iron/sulfate reduction and methanogenesis in flooded soil

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Biochar has received increasing attention for its many environmental impacts in recent years, but there is still a lack of comprehensive understanding of its effects on the fate of reducible organic pollutants and soil biogeochemical processes under anaerobic environments. In this study, anaerobic batch experiments were conducted to explore the effect of biochar on reductive transformation of PCP and other soil redox processes in anaerobic incubation environment. Results showed that biochar had little impact on the system Eh and pH, both of which decreased gradually to a stable value during the incubation. Dissimilatory iron reduction and sulfate reduction were significantly enhanced following biochar addition, with the promoting effect more prominent in the treatment with 1% (w/w) than that with 5% biochar added. In addition, biochar accelerated the formation of carbon dioxide and methane, but there was no difference in the final content of these two greenhouse gases at the end of incubation between biochar amended and control treatments. Unexpectedly, compared to biochar-free controls, the reductively dechlorinated degradation of PCP was inhibited following biochar addition, with the inhibition extent increased with the increase of biochar amount. These revealed an interesting biochar effect that suppressed the dechlorination of PCP, but promoted the iron/sulfate reduction and accelerated the methanogenesis. It might be simultaneously mediated by the functional microbial groups that responded sensitively to the addition of biochar and/or PCP, including the potential dechlorinators, the potential iron/sulfate reducers, and the typical methanogenic archaea. Specific function of biochar as electron shuttle was also likely involved in underpinning this interesting effect, since biochar would be capable of splitting the limited electrons from the inferior electron acceptors (in our case, the PCP) to the dominant more competitive ones (in our case, Fe(III) and SO_4^{2-}), when the electron donors were limited for guaranteeing an completely entire reduction processes through microbial anaerobic respiration in natural flooded soil. Our study took a step forward regarding a synthetic understanding of biochar's function in soil remediation, and may provide improved strategy for optimizing the remediation of flooded soil and sediment polluted by chlorinated organic pollutants such as PCP.

Keywords: Biochar; Reductive dechlorination; Redox process; Microbial community

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