Biochar amendment increases arsenic release from flooded paddy soil by modulating the transcriptional activity of arsenic-reducing bacteria and genes

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Chars (biochar) make up significant fractions of the organic matter in many soils and sediments, which has exhibited great potential in heavy metal remediation. However, its impact on arsenic biogeochemistry in paddy fields remains poorly characterized. In this study, the potential influence of biochar amendment on arsenic biogeochemistry in an arsenic-contaminated paddy soil was investigated using microcosm experiments under anoxic conditions, in which lactate, a rice root exudate, was used as the organic carbon source. Compared with Soil treatment, microbial reduction of As(V) and Fe(III) was simultaneously enhanced by the addition of both biochar and lactate, resulting in more toxic As(III) release from flooded paddy soil. Only small amounts of arsenic release and reduction were detected in the presence of biochar. After incubated with biochar and lactate, the potentially active *Anaeromyxobacter*, *Azoarcus*, *Geobacter* and *Pseudomonas* were highly enriched according to RNA-based sequencing, and in particular, ArrA (respiratory arsenate reductase) related to *Geobacter* species (>60%) and ArsC (cytoplasmic arsenate reductase) related to *Enterobacteriaceae* (>99%) were selected. Quantitative reverse transcription-PCR showed that the number of transcripts from *Geobacter* species, *Geobacter arrA* and *arsC* gene were stimulated by biochar when lactate was supplied. Furthermore, in the presence of both lactate and biochar, transcript abundances of *Geobacter* species and *Geobacter arrA* closely tracked with dissolved As(V) concentrations. The results indicate that introduction of biochar in paddy soil can facilitate microbially mediated arsenic transformation when organic substrate is provided, and *Geobacter* species are the potentially active bacteria associated with arsenic release and reduction in paddy soil, which can be stimulated by biochar.

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