Humic substances enhance arsenic reduction in paddy soil via abiotic reaction and stimulating functional microbial community

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Humic substances (HS) are major class of naturally occurring redox-active organic compounds, and serve as electron shuttles that promote the electron transfer from microorganisms to extracellular electron acceptors. However, little is known about the relationship between arsenic reduction and HS in paddy soil. Here, anaerobic microcosms were set up amended with three humic fractions (fulvic acid, FA; humic acid, HA and humin, HM) to investigate the influences of HS on arsenic reduction in flooded paddy soil. Chemical analyses reveal that the rate and extent of As(V) reduction was significantly higher in the HS amended-soil microcosms compared to the soil only control, which is associated to the electron transfer capacity of HS. In addition, the microbially reduced FA releases approximately 50-70% of the total dissolved arsenic in the FA-amended soil. This result highlights the important contribution of microbially reduced HS in arsenic reduction and release in natural paddy soil. Furthermore, HS can affect microbial community for arsenic reduction. The *arrA* gene transcripts clone library shows that FA amendment selected for ArrA related to *Geobacter* sp. OR-1 while HA and HM selected for ArrA that were related to uncultured organisms. HS can directly stimulate *arrA* gene and arsenic-respiring *Geobacter* spp. transcripts to enhance microbial As(V) reduction. These results provide new insights into our understanding of interactions between humic substances and arsenic biogeochemistry in nature paddy soil.

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