Arsenic transformation in paddy soil and impact on arsenic accumulation and speciation in rice

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Rice is a major dietary source of the carcenogenic inorganic arsenic (As_i) for populations consuming rice as the staple food. Arsenic accumulation in rice is elevated compared with other cereal crops. This is because the anaerobic conditions in flooded paddy soil lead to mobilization of arsenite and the inadvertent, yet highly efficient, uptake of arsenite by rice roots via the silicic acid uptake pathway. Anaerobic conditions in paddy soil also favour arsenic methylation mediated by microorganisms. Methylated As species can account for a substantial proportion of the total As in rice grain depending on the soil conditions and the geographical region of rice cultivation. These organic As species are derived from soil microoganisms. Methylated As species are also taken up by silicic acid transporters in rice roots and are preferentially transported to rice grain. Under aerobic conditions experienced by upland or aerobic rice, arsenate is the major As species taken up by rice roots via the phosphate transporters. Arsenate is reduced to arsenite by arsenate reductases; the latter can be extruded to the rhizosphere, complexed with thiol compounds or transported to rice shoots and grain. Rice roots release oxygen to the rhizosphere via the arenchyma. This process has a profound impact on As dynamics in the rhizosphere. Recent progress in the understanding of microbial As transformation in paddy soil and the molecular mechanisms responsible for the uptake and translocation of As species in rice will be discussed.