Monothioarsenate uptake, transformation, and translocation in rice plants

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Rice (*Oryza sativa*) is the major staple food worldwide. Its growth under flooded, reducing conditions mobilizes Arsenic (As) from the soil which can be taken up and accumulate in rice grains, presenting a serious health hazard. So far, studies focused on the uptake and biotransformation of inorganic (arsenite and arsenate) or organic (mono- and dimethyl arsonic acid) As species. We recently showed that under sulfur-reducing conditions not only arsenite, but also thioarsenates ($HAsS_nO_{4-n}^{2-}$, n=1-4), structural analogues to arsenate, can form. No information is available yet on how their presence changes total arsenic uptake, transformation and translocation in rice plants. In the present study we used monothioarsenate (MTA) because of its slow transformation kinetics under fluctuating redox conditions typical for paddy fields and the fact that its formation does not require a huge excess of free sulfide but only the presence of element sulfur.

Growth inhibition experiments showed that MTA toxicity was between arsenite and arsenate, similar to results for *Arabidopsis thaliana*[1]. To prove that MTA was directly taken up by rice plants, we developed a species-preserving extraction method for plant samples. Up to 19 and 4% MTA were detected in roots and shoots respectively, when plants were exposed to 10 µM MTA for 72 h. Furthermore, we found MTA in xylem saps, as well as in root exudates. Our experiments showed for the first time that MTA can be directly reduced to arsenite in rice shoots and roots. Total As uptake was lower when rice plants were exposed to MTA compared to arsenate, but root to shoot translocation was higher for MTA-exposed rice plants. Transport and detoxifying mechanisms in plants are not known for MTA and need to be studied. Better understanding these mechanisms could clarify whether low MTA uptake has the potential to generally decrease the As uptake in rice plants and therefore limit As accumulation in rice grains.

[1] Planer-Friedrich et al. (2017) *ES&T* **51**, 7187-7196.