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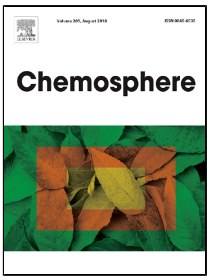

Extractive recovery and valorisation of arsenic from contaminated soil through phytoremediation using *Pteris cretica*

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Extractive recovery and valorisation of arsenic from contaminated soil through phytoremediation using *Pteris cretica*

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Abstract

Contamination of ground water and soil by arsenic poses serious environmental challenges globally. A possible solution to this problem is through phytoremediation using hyper-accumulating plants. This study investigates phytoremediation of soil containing 200 ± 3 mg kg^{-1} of arsenic using *Pteris cretica* ferns, and the strategies for arsenic extraction from the ferns biomass and subsequent conversions to valuable arsenic products. The *Pteris cretica* ferns achieved maximum arsenic accumulations of 4427 ± 79 to 4875 ± 96 mg of arsenic per kg dry biomass after 30 days. Extraction efficiencies of arsenic in the ferns fronds were 94.3 ± 2.1% for ethanol-water (1:1 v/v), 81.5 ± 3.2% for 1:1(v/v) methanol-water, and 70.8 ± 2.9% for water alone. Molybdic acid process was used to recover 90.8 ± 5.3% of the arsenic, and 95.1 ± 4.6% of the phosphorus in the biomass extract. Quantitative precipitation of $Mg_3(AsO_4)_2$ and $Mg_3(PO_4)_2$ occurred on treatment of the aqueous solutions of arsenic and phosphorus after stripping at pH of 8 – 10. The efficiencies of $Mg_3(AsO_4)_2$ and $Mg_3(PO_4)_2$ precipitation were 96 ± 7.2% and 94 ± 3.4%, respectively. Arsenic nanoparticles produced from the recovered $Mg_3(AsO_4)_2$, using two-stage reduction process, had average particle diameters of 45.5 ± 11.3 nm. These nanoparticles are potentially valuable for medical applications, while the $Mg_3(AsO_4)_2$ could be converted to more valuable forms of arsenic or used as a pesticide, and the $Mg_3(PO_4)_2$ in fertiliser. Recovery of these valuable products from phytoremediation biomass would incentivise and drive commercial industries' participation in remediation of contaminated lands.

Keywords: Phytoremediation, hyper-accumulator, *Pteris cretica*, solvent extraction, molybdic acid process, arsenic nanoparticles.