Removal of chromium from aqueous solutions using biogenic magnetite-organic complex nanoparticles

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The particular characteristics of biogenic minerals, such as their high specific surface area and high reactivity, as well as the presence of a bacterial carrier matrix make them interesting for various applications, for instance as adsorbents, catalysts, oxidants or reductants [1]. The objective of this study was to examine the removal of Cr(III/VI) using biogenic magnetite nanoparticles (BMNs) produced by metal-reducing bacteria.

In order to produce BMNs, the metal-reducing bacteria (Geocha-1) enriched from intertidal flat sediments in S. Korea were grown with a poorly crystaline iron-oxide, akaganeite, as an electron acceptor, and glucose as an electron donor. The BMNs were harvested via washing and freeze-dry processes. The interactions between ionic Cr(III/VI) and freeze-dried BMNs were examined under different solution pHs (pH=2–12) using different dose of BMNs (0-6 g/L) for 2 weeks at 25℃. After reaction, the BMNs were separated from the Cr-contaminated water using a magnet. The experiments using chemically synthesized magnetite nanoparticle (CMNs) were conducted as control. Mineralogical characterization of BMNs was performed by XRD and TEM-EDS analyses. And XPS and ICP analyses were used to determine the amount of Cr(III/VI) removed after reaction. The BMNs were spherical in shape and around 10 nm in size. The surface area of the freeze-dried BMNs was measured to be 101 m^2/g. Unlike CMNs, the BMNs were coated with organic matter containing an abundance of reactive carboxyl groups (-COOH). As results of Cr(III/VI) removal test, BMNs showed higher Cr(VI) removal efficiency (approx. 99%) than CMNs (approx. 82%) did for 2 weeks of reaction time. The lower pH of Cr-contaminated solution and longer reaction time, the higher Cr(VI) removal efficiency showed. BMNs coated with organic matter were more effective to lead adsorption of Cr(III) with electrostatic interaction (approx. 82%) and to prevent oxidation of Fe(II) within the magnetite structure than CMNs (approx. 13%). Therefore, microbially formed functional magnetite-organic complex nanoparticles have high potential to useful and applicable decontaminant for ionic chromium in environmental remediation technologies.

[1] Hennebel et al. (2008) *Trends. Biotechnol.* **27**, 90-98.