Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16211

Valorization of waste iron substrates for the production of functional Fe(II) nanomaterials

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The present study demonstrated a biotechnological approach to utilize waste iron residues from drinking water production for synthesizing biovivianite (a potential fertilizer) by the Fe(III)-reducing bacterium, *Geobacter sulfurreducens*. The waste iron residue consisted of iron sludges (non-pelletized wet sludge) from 2 groundwater treatment facilities. Six sets of pelletized iron sludges, with and without added phosphate (dry pellets – FerroSorp (FS), P-loaded FS, Noordbergum (NB), P-loaded NB, and Shwertmannite (SHM), P-loaded SHM) were also used. The influence of P adsorption on the biotransformation of Fe(III) materials was investigated using batch incubations. The extent of bioreduction was higher in the pelletized Fe(III) materials than in the P-loaded counterparts, and dependent on the crystallinity of the substrate. Thus, Fe(III) material dominated by 2-line ferrihydrite (as in the case of FerroSorp) according to XRD analysis, showed a higher bioreduction extent compared to those with Schwertmannite as the main composition. For the non-pelletized Fe(III) material (wet sludge), a treatment ratio of P/Fe of 1 supported the highest rate and extent of Fe(II) production. Vivianite and siderite were formed in the phosphate and zero-phosphate treatments respectively. Previous studies have successfully used synthetic vivianite and siderite to treat Fe chlorosis in plants [1 – 3]. Parallel experiments are investigating the use of biovivianite on the treatment of Fe deficiency (chlorosis) in plants grown in calcareous soils. Collectively these studies contribute to the overall goal of sustainable waste reuse and resource recovery, which reinforces circular economy.

Keywords: Fe(III)-reducing bacteria, Waste iron, Vivianite.

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