SOIL AND WATER CONTAMINATION FROM TANNERY WASTE; FATE, DISTRIBUTION AND REMEDIATION OF CHROMIUM

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Tanneries frequently use chromium heavy metal for leather manufacturing process resulting in high strength waste waters; as a result chromium and other pollutants are released to the soil and water systems. The objective of this research was to determine chromium concentrations in tannery waste water, surrounding soils and neighboring plants and to screen possible amendments to immobilize chromium in the waste water and soil. The soil incubation experiment was conducted for 120 days using tea waste (5%), tea waste biochar (TWBC) pyrolyzed at 300 °C (5%), synthesized Fe oxide (1%) and Zr-Fe oxide (1%). Adsorptive remediation of Cr(VI) in aqueous media using gibbsite was investigated as a function of pH, contact time, heat treatment of gibbsite and background electrolyte concentration via batch experiments. Interaction between Cr(VI) and gibbsite heated to various temperatures (200, 300, 400 and 600 °C) were evaluated.

The chromium concentrations in the tannery waste water and soils were ranged from (179±234) mg L^{-1} and (13298±3308 mg kg^{-1}), respectively. Plants in the neighboring environment showed high concentrations of chromium in roots and shoots. *Boerhavia diffusa* L. showed high translocation factor (2.426) indicating its potential to serve as a phytoextractor. After 120 days of the addition of amendments, a slight reduction of exchangeable fraction was observed in all amendment application. Sequential extraction revealed that chromium was mainly bound to organic matter and carbonate bound fractions of the soil. Iron oxide and Zr-Fe oxide showed only a slight immobilization capacity for chromium in tannery waste contaminated soil. The TWBC treatment reduced 90%, 50% and 40% of DTPA, $CaCl_2$ and EDTA extractable chromium, respectively. FeO treatment reduced exchangeable chromium by 90%. Application of TWBC increased organic matter bound chromium concentration by 25%. Hence, combined use of TWBC and Fe oxide could be feasible to immobilize chromium in the tannery waste-contaminated soil and protect the soil, plant and water systems.

Maximum adsorption capacity for Cr(VI) of 8.57 mg/g was reported for 300 °C heated gibbsite under acidic medium. The results suggest that adsorption of Cr(VI) decreased with an increase of pH. Aqueous solution with initial pH of 4.0-5.0 was most favorable for Cr(VI) removal. Catalytic activity of H_2O_2 showed negligible variation of Cr(VI) adsorption to gibbsite and sorption remains almost unchanged. There was no significant different in the effect of background electrolyte concentration on the rate of Cr(VI)

adsorption. Adsorption isotherm results show a good fit with Freundlich isotherm indicating multilayer sorption could be more favorable for Cr(VI) adsorption in to homogenous $\equiv AlOH$ sites under conditions employed. The experimentally obtained Gibb's free energy value from adsorption thermodynamics showed that the Cr(VI) adsorption was spontaneous. The kinetics studies carried out in order to determine the rate of adsorption indicated the pseudo second order kinetics. Gibbsite shows greater affinity to Cr(VI) and hence it can be recommended as an excellent lo-cost sorbent for the removal of toxic Cr(VI) from tannery waste water.