

SRI LANKAN LATERITE – AN ADSORBENT FOR TETRACYCLINE IN AQUEOUS MEDIA

U.S.T. Sachintha¹, I.M. Wijekoon² and N.H. Koralegedara^{1*}

¹Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka.

²Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka.

*nadeeshak@sci.pdn.ac.lk

Antibiotics and their residues are considered as emerging contaminants, as their accumulation in the environment causes antibiotic resistance among microorganisms. Hence, accumulation, prevention, and immediate removal of antibiotics are essential. Laterite (LT), a naturally occurring iron-rich soil, is a well-known adsorbent for many environmental contaminants. However, its application in antibiotic adsorption is limited. Hence, this study investigates the adsorption potential of raw LT in removing tetracycline (TC), a widely used antibiotic that is frequently detected in aquatic environments. Batch adsorption experiments were conducted to assess the TC removal potential of LT under different conditions. TC solutions of known concentrations (1, 4, 17, 50, 72 mg L⁻¹) were thoroughly mixed with LT over specified contact times (5, 10, 30, 60, 120, 180, 240 min) and analysed for TC concentrations using a UV spectrophotometer (at $\lambda_{\text{max}} = 352.1$ nm). The effects of pH (3, 4, 5, 7, 10), adsorbent dosage (5, 10, 15, 20 g L⁻¹), and the soil organic matter (OM) were investigated. Optimum removal was observed at pH 5 – 7 with 10 g L⁻¹ adsorbent dosage, and in the absence of OM. The low adsorption observed at both acidic (pH < 5) and alkaline pH (pH > 7) is attributed to electrostatic repulsion between LT and TC due to their similar surface charges (pH_{zpc} of LT = 5.8 and pK_a of TC is 3.3, 7.7, and 9.7). As TC exists in its zwitterionic form at pH 3.3 – 7.7, the maximum adsorption is observed at pH 5 – 7. TC Adsorption data followed the Langmuir isotherm model ($R^2 = 0.9981$), indicating monolayer adsorption on a homogeneous surface. Kinetics data aligned the best with the pseudo-first-order model, suggesting that an electrostatic attraction-initiated interaction between LT and TC. Furthermore, Fourier transform infrared spectroscopic analysis confirmed the complexation between TC and Fe and Al groups of LT by changes in relevant peak positions and intensities, indicating electrostatic attraction followed by hydrogen bonding and metal-ligand coordination. These findings highlight the potential of laterite as a sustainable, low-cost, and eco-friendly adsorbent for TC removal in contaminated water systems.

Financial assistance from University of Peradeniya (Grant No. 486) is acknowledged.

Keywords: Adsorption, Antibiotic, Fe-rich soil, Remediation, Tetracycline