Supplementary Material S3 Characterization analysis:

The surface morphology of the adsorbent materials was examined using a field emission scanning electron microscope (SEM, Thermo Scientific Apreo 2C USA), while the elemental distribution on the adsorbent surface was observed using an energy dispersive spectrometer (EDS, OXFORD ULTIM Max65 UK). The specific surface area and pore size distribution of the adsorbents were analyzed by a fully automatic surface area and porosity analyzer (BET, Micromeritics ASAP 2460 USA). The diffraction patterns of the adsorbents were observed using an X-ray diffractometer (XRD, Rigaku Ultima IV Japan), and the changes in surface functional groups were analyzed by Fourier transform infrared spectroscopy (FTIR, Bruker Tensor 27 Germany). The elemental composition, concentration, chemical state, and molecular structure on the adsorbent surface were investigated using an X-ray photoelectron spectrometer (XPS, Thermo Scientific K-Alpha USA), with all binding energies (BEs) referenced to the C1s hydrocarbon peak (284.8 eV). The Zeta potential of the adsorbents at different pH values was observed using a dynamic light scattering (DLS) instrument, Malvern Zetasizer Nano ZS90 UK. The material after phytic acid adsorption was prepared and characterized in a solution with pH = 7.