

Background

Water scarcity and pollution are major challenges in the world today. The major water pollutants include heavy metals, pesticides, dioxins, furans, phenolics, and dyes.

Consumption of these pollutants triggers the emergence of diseases, including cancer in both humans and animals. Dyes are colored pollutants that hinder photosynthesis and increase the biochemical oxygen demand (BOD) by preventing the penetration of light in water.

They get into the water bodies through the disposal of untreated and partially treated wastewaters by agricultural and industrial processes. Therefore, there is a need for an affordable and effective technique for water treatment.

Adsorption is proven to be the superior technique compared to the others, as it is easy to design, reusability, and effective in removing a wide range of pollutants from aqueous solutions. The adsorbents used should be abundant, affordable, and with the desired adsorption properties. In addition, they should be porous, with high specific surface area and high binding capabilities.

Water hyacinths possess these properties; are abundant, has low economic value, and are porous.

On the other hand, nanotechnology offers a high surface area, super magnetic properties, and high adsorption capacities, among others.

This study investigates the efficiency of water hyacinth's biochar-MWCNTs to adsorb Rhodamine B from water. The adsorbent's functional groups, atomic, and morphological information were characterized using Fourier Transform Infrared Spectroscopy, X-Ray Diffraction, and Transmission Electron Microscopy.

Methods

Dried water hyacinth's leaves were carbonized by slow pyrolysis and the biochar filtered to 72µm pore size. Two composites were prepared in the ratio; biochar-CNT (97.5:2.5) and biochar-CNT (95:5) using glutaraldehyde as the cross-linker.

Results

The optimum sorption of RhB by these adsorbents was determined by varying dye contact time, adsorbent dose, dye concentration, and pH of the solution. The concentration of RhB was determined by UV/VIS.

About a kilogram of dry hyacinths (stem and leaves) were carbonized at 350°C, yielding approximately 300g (30%) of the biochar.

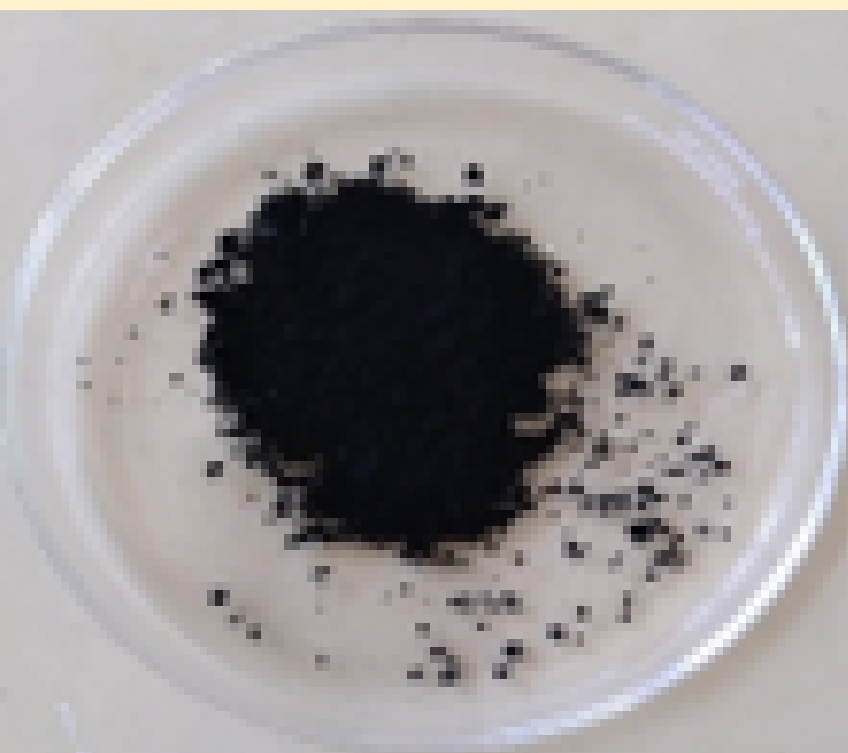


Figure 1: 72 µm pore biochar

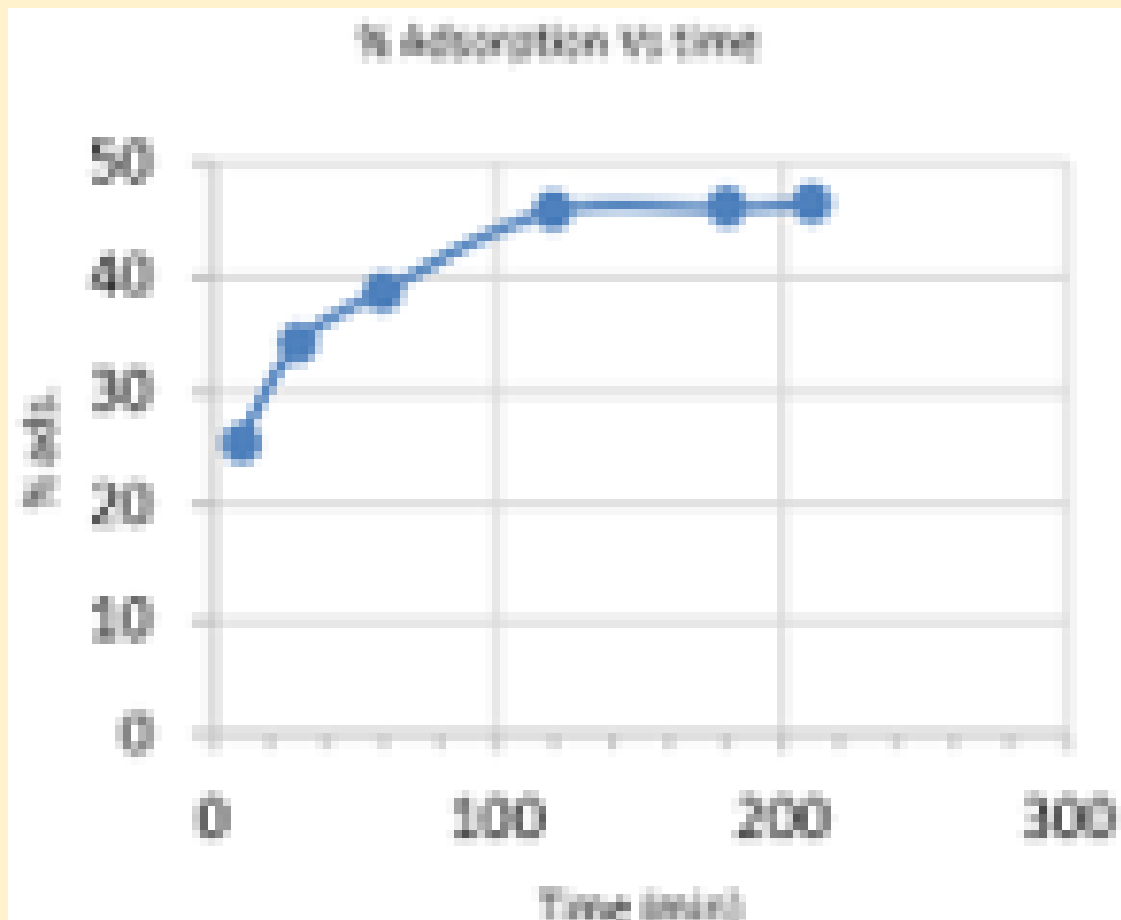


Figure 2: Effects of contact time on the adsorption of RhB [conditions: RhB concentration (10ppm), adsorbent dose (50mg in 50ml), temperature (room temperature), pH (constant)]

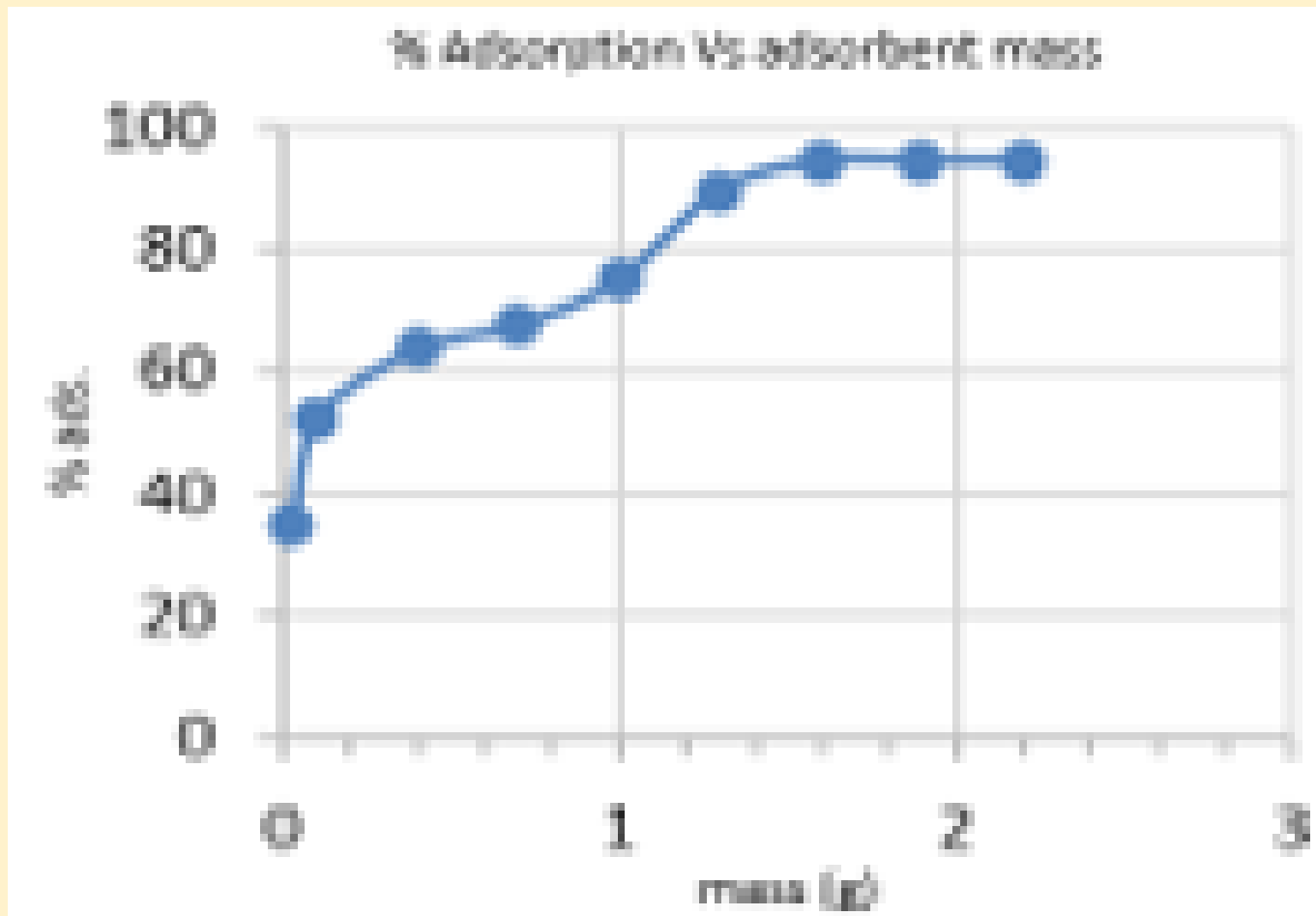


Figure 3: Effects of adsorbent dose on the adsorption of RhB [conditions: RhB concentration (10 ppm), contact time (2 hours), Volume (50 ml), temperature (room temperature), pH (constant)]

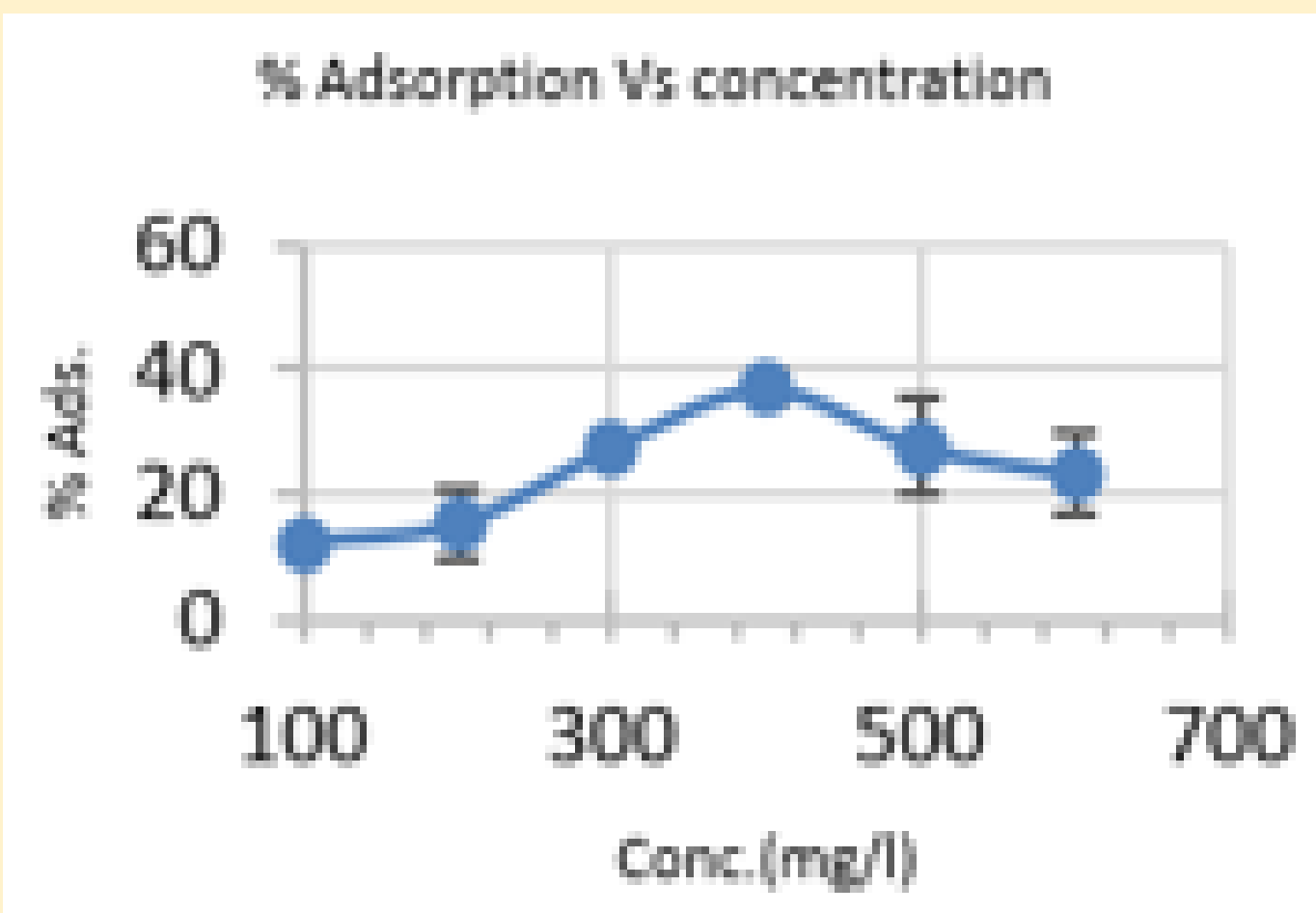


Figure 4: Effects of RhB concentration on the adsorption of RhB [conditions: adsorbent dosage (10 g/l), contact time (2 hours), temperature (room temperature), pH (constant)]

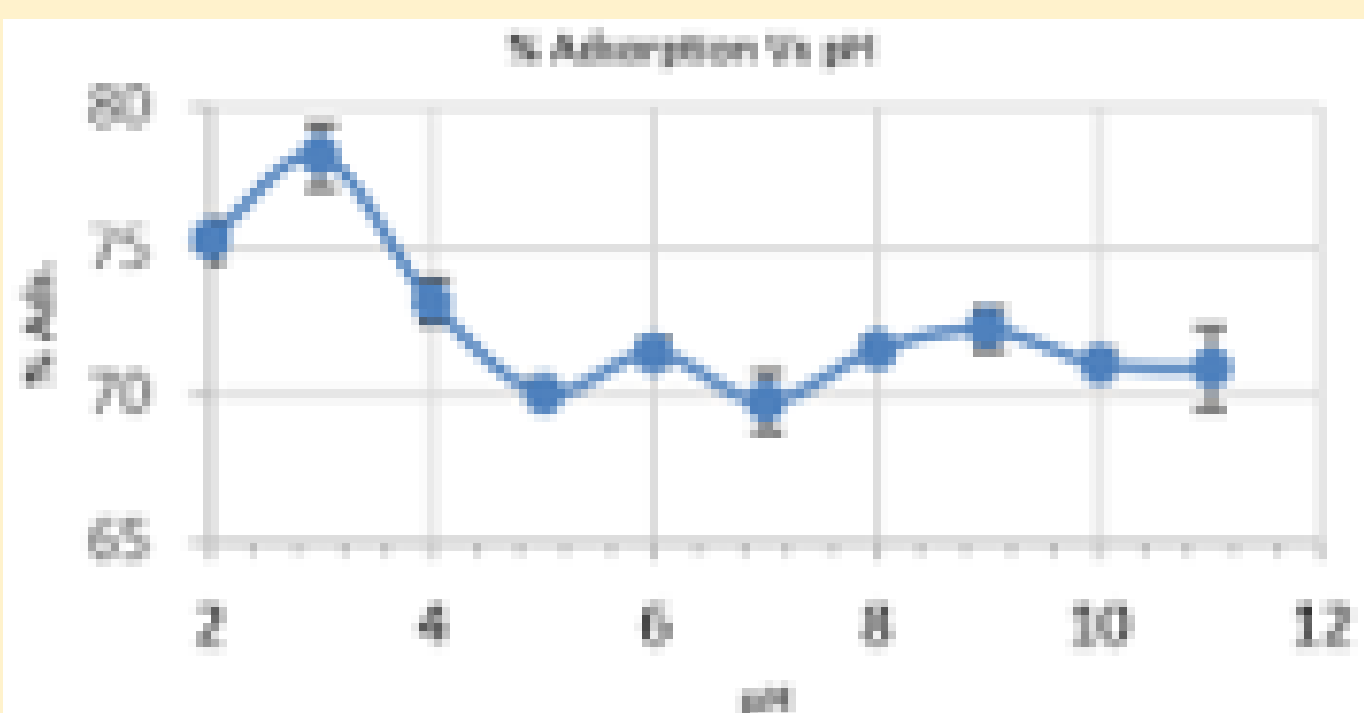


Figure 5: Effects of pH on the adsorption of RhB [conditions: contact time (2 hours) Adsorbent dose (10 g/L), the concentration of RhB (50 ppm), temperature (room temperature)]

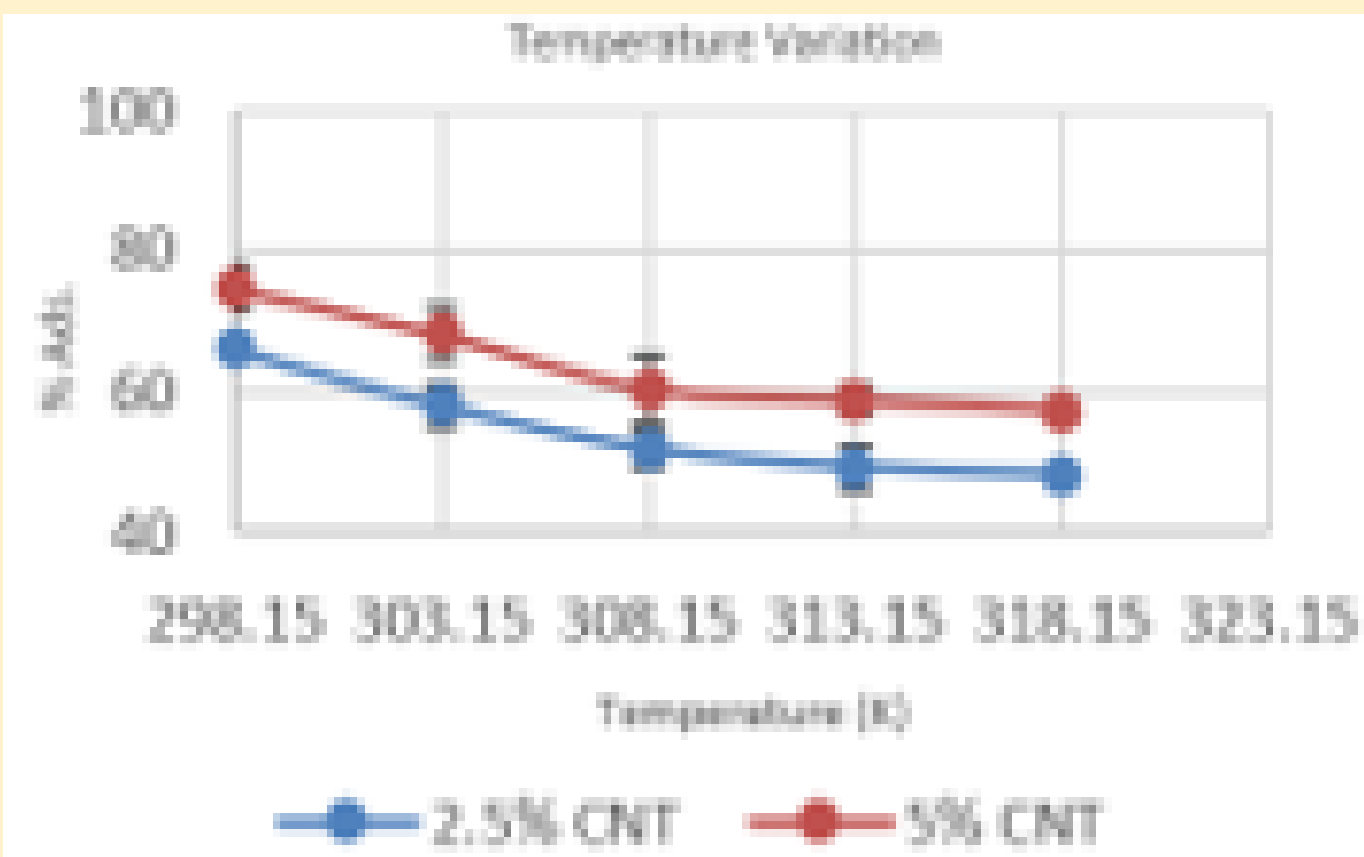


Figure 6: Effects of temperature on the adsorption of RhB [conditions: contact time (2 hours), Adsorbent dose (1.6g in 100ml), concentration of RhB (400 mg/l), pH 3].

Furthermore, the adsorption of RhB was better described by Freundlich isotherm and Pseudo-second-order as shown below:

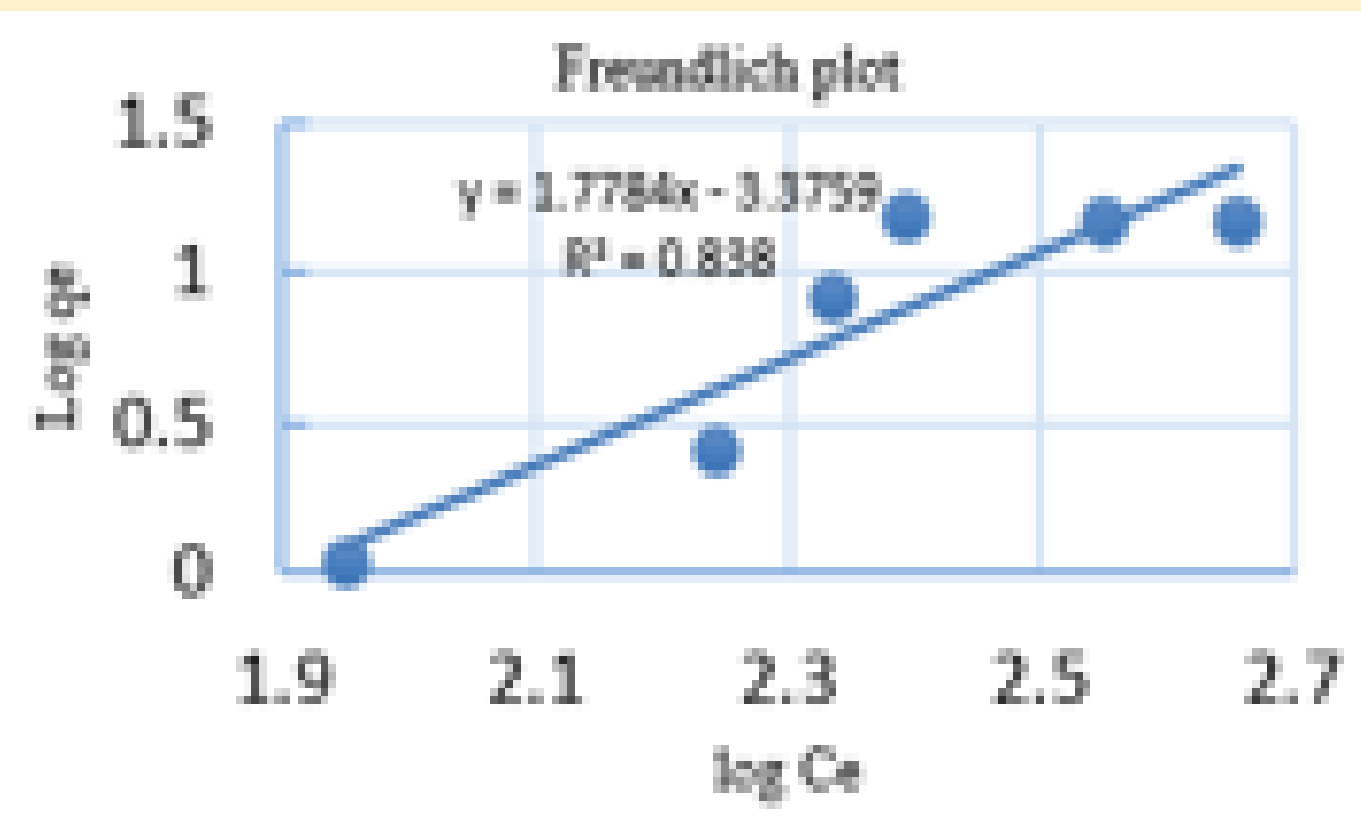


Figure 7: Linearized Freundlich plot for the adsorption of RhB

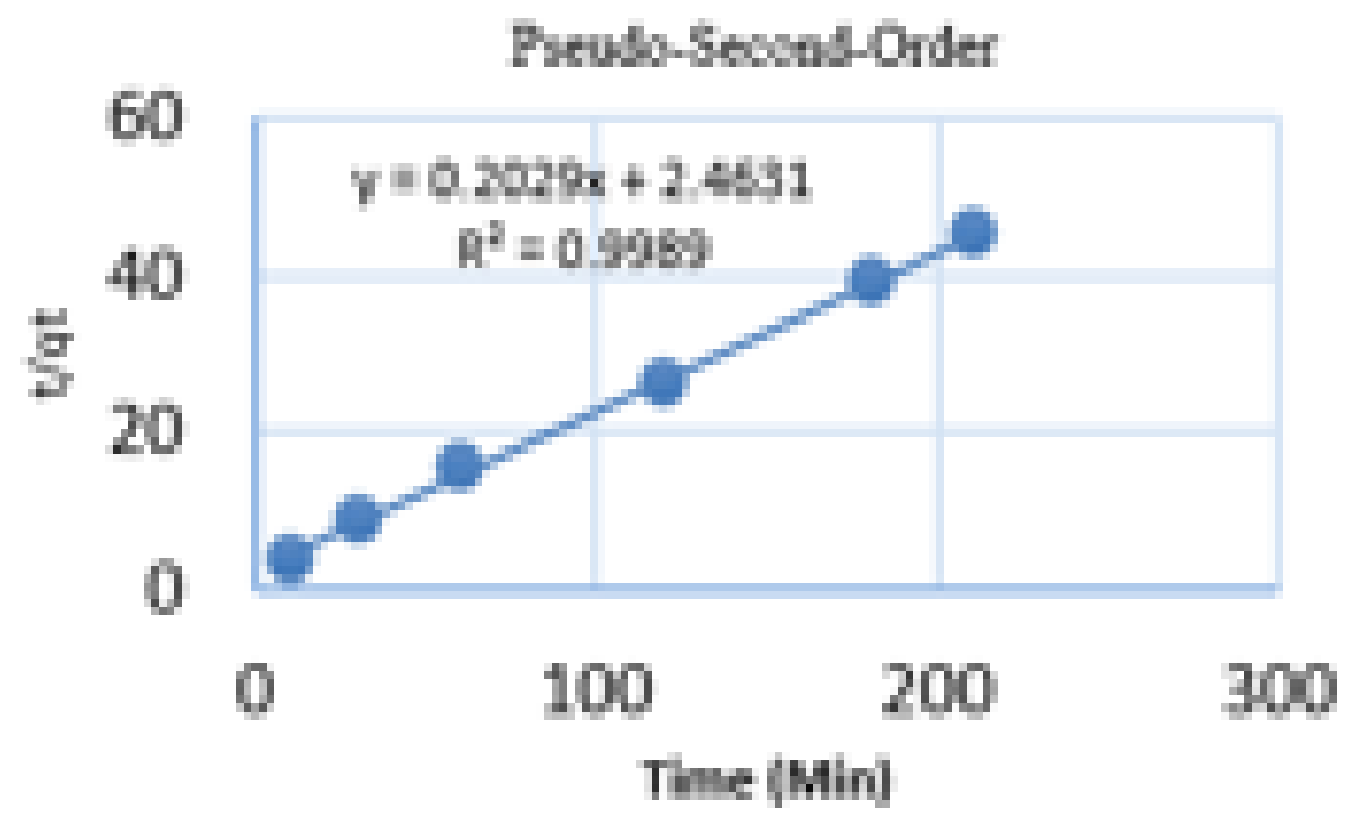


Figure 8: Linearized pseudo-second-order plot for the adsorption of RhB.

Conclusion

A maximum adsorption percentage of RhB on biochar, 2.5%, and 5% CNT to be 36%, 66%, and 75%, respectively. Adsorption was optimal at the following conditions: 2 hours contact time, 400 ppm of the adsorbate, 1.6g of the adsorbent, pH 3, and room temperature