ABSTRACT

OTC is a prevalent antibiotic contaminant in wastewater, endangering the environment. The structural and adsorption characteristics of the hydrogel were investigated, taking into account parameters such as pH, temperature, contact duration, and starting OTC concentration. The study sheds light on the potential of this hydrogel for long-term pharmaceutical wastewater treatment. Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and kinetic models were used to examine the hydrogel's composition, which included Carrageenan, Polyvinyl Alcohol (PVA), and Bentonite Nano-clay. The results revealed considerable changes in the vibrational modes and absorption bands of the hydrogel, suggesting effective functionalization of Bentonite nano-clay.The maximum removal efficiency was attained at a concentration of 40mg/L with pH =8 and an adsorbent dose of 0.1g (KPB-3)is 98.5% within 140 min. Adsorption of OTC increased upto 99% with increasing starting concentrations.Furthermore, the maximum removal efficiency of 95 % for oxytetracycline using kappa Carragenan -based hydrogel film was achieved with an initial concentration of 20mg/L and an adsorbent dose of 0.1g within 60 min. The kinetic modelling of OTC adsorption onto several adsorbents (KPB-1 to KPB-6) reveals that chemisorption processes outnumber physical adsorption. The Pseudo-Second-Order model, which emphasises the importance of chemical adsorption in the removal process, is better suited to represent the adsorption behaviour. Excellent matches are found that R_2= 0.99 for KPB-3,R_2= 0.984 for KPB-2 and R_2= 0.989 for KPB-1 indicates strong chemical bonding interactions. The statistical approach has done. Anova showed that both pH and concentration have a significant influence on OTC adsorption by the hydrogel, with p-values less than 0.05. The efficiency of OTC removal, on the other hand, has a p-value of 0.054, which is marginally higher than 0.05, indicating a less clear-cut relevance. Correlation showed that Initial Concentration has strong positive correlations with pH, Temperature, and Contact Time, all of which indicate weak positive linear associations. The research provides the new insights that at using a Kappa carrageenan-based hydrogel with Bentonite Nano-clay and PVA for efficient OTC removal from pharmaceutical effluent. This study adds to the development of sustainable wastewater treatment systems and environmental engineering.
Keywords: oxytetracycline, Kappa carragenan, hydrogel, Bentonite Nano-clay.