**Advances in Nano Research**, *Vol. 11, No. 6 (2021) 667-678*
https://doi.org/10.12989/anr.2021.11.6.667


# Drug adsorption and anti-microbial activity of functionalized multiwalled carbon nanotubes

Megha Saxena[1], Disha Mittal[2], Richa Boudh[1], Kapinder Kumar[2], Anita K. Verma[2] and Reena Saxena*[1]

*[1]Department of Chemistry, Kirori Mal College, University of Delhi, Delhi 110007, India*
*[2]Nanobiotech Lab, Department of Zoology, Kirori Mal College, University of Delhi, Delhi 110007, India*

(*Received November 23, 2020, Revised October 25, 2021, Accepted October 31, 2021*)

**Abstract.** Multiwalled carbon nanotubes (MWCNTs) were first oxidized (O-CNTs) to introduce carboxylic group and then further functionalized (F-CNTs) with m-phenylenediamine, which was confirmed by FTIR and SEM. It was used as an effective adsorbent for the adsorptive removal of diclofenac drug from water. Under optimum conditions of pH 6, stirring speed 600 rpm, the maximum adsorption capacity obtained was 532 mg $g^{-1}$ which is superior to the values reported in literature. The adsorption was quite rapid as 25 mg $L^{-1}$ drug solution was adsorbed in only 3 minutes of contact time with 10 mg of adsorbent dose. The adsorption kinetics and isotherms were studied using various models to evaluate the adsorption process. The results showed that the data best fit in kinetics pseudo-second order and Langmuir isotherm model. Furthermore, the oxidized and functionalized MWCNTs were applied on gram-negative Escherichia coli and gram-positive Staphylococcus aureus using agar disc diffusion assay to validate their anti-microbial activity. Results were unique as both oxidized and functionalized MWCNTs were equally active against both *E. coli* and *S. aureus*. The newly synthesized F-CNTs have great potential in water treatment, with their dual action of removing drug and pathogens from water, makes it potential applicant to save environment.
**Keywords:** adsorption; antimicrobial; diclofenac; functionalized multiwalled carbon nanotubes; m-phenylenediamine

## 1. Introduction

Pharmaceuticals are produced to save human life from many deadly diseases. However, prolonged presence of a pharmaceutical in water makes it an emerging pollutant which causes hazardous effect on living beings. Since pharmaceutical drugs are generated to affect the target parts of body or cells and are prescribed with precaution about their doses and quantity. Higher or improper dosage of these can cause certain severe side effects or even lead to death. Nowadays, the excessive presence of pharmaceutical drugs in water bodies which could be due to hospital effluents or pharmaceutical industrial waste becomes a serious problem for whole ecosystem (Patel *et al*. 2019). Various pharmaceutical drugs like aspirin, paracetamol, etc., are used in hospitals as first aid or to cure different diseases. Diclofenac sodium is the most popular drug that used as pain killer. The chemical name of Diclofenac is 2-(2, 6-dichloranilino) phenylacetic acid and it is an anti-inflammatory drug which is used to reduce inflammation and help in relieving pain. Diclofenac with its high consumption rate and poor degradation can't be removed completely by simple wastewater treatment plants. So, it easily passes in river water, ground water, etc., which is used for drinking purpose. Its high amount has detrimental effect on human health.

Diclofenac in human body affects kidney attributed to Ischaemia induced by inhibition of prostaglandin synthesis resulting in tubular necrosis. It can cause serious hepatotoxicity (Liver damage). Diclofenac also has adverse effect on aquatic species such as endocrine disruptor in Daphnia magna. It can destroy the eggs of fishes (Lonappan *et al*. 2016). Since the pharmaceutical removal is difficult it became a challenge for researchers to find an effective method for its removal. There are various methods such as membrane filtration (Ouyang *et al*. 2019), electro-coagulation (Ensano *et al*. 2019), oxidation (Kanakaraju *et al*. 2018), photocatalytic degradation (Mestre and Carvalho 2019), adsorption (Ighalo and Adeniyi 2020) etc. which are used to remove the pharmaceuticals from wastewater. Adsorption is the most common method which is low cost, effective and easily combines with wastewater treatment plants. There are various adsorbents like activated carbon (Mansour *et al*. 2018), alumina (Chauhan *et al*. 2020), silica (Barczak *et al*. 2020), cellulose (Raicopol *et al*. 2019) and chitosan (Pereira *et al*. 2020), which shows good removal of pharmaceuticals but suffers certain limitations like low capacity and high cost. Nowadays, nanomaterials like metal oxide nanoparticles, silica nanoparticles, chitosan nano-particles and carbon nanotubes-based nanoparticles are used for pharmaceutical removal (Saxena *et al*. 2020). Carbon nanotubes (CNTs) are the most popular adsorbent due to their large surface area, high adsorption capacity, stability and ease of modification. These inherent unique properties of CNTs offer an exciting platform to enable significant research opportunities (Ebrahimi and Mahmoodi 2018). Surface functionalization of CNTs with different modifying agents or organic moieties improves its hydrophilicity and makes it biocompatible for biomedical applications. Functionalization further facilitates the complex formation capability of CNTs, thereby enhancing its selectivity

*Corresponding author, Professor,
E-mail: rsaxena@kmc.du.ac.in


http://www.techno-press.org/?journal=journal=anr&subpage=5
ISSN: 2287-237X (Print), 2287-2388 (Online)