SYNTHESIS OF MAGNETIC GRAPHENE OXIDE-BIOPOLYMER FOR IBUPROFEN REMOVAL FROM WATER

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Ibuprofen, a common non-steroidal anti-inflammatory medication, has environmental impacts when it enters water systems. Treatment plants struggle to eliminate it, leading to aquatic harm. Fish endocrine disruption and interference with algae growth are evident. The carbonaceous materials are of research interest also due to their pollutant adsorption capabilities. This study presents a greener fabrication of graphene oxide hybrid material for ibuprofen removal. Excellent yields and structure confirmation through analyses are achieved. Conditions like pH and the mass of the adsorbent have an influence on the ibuprofen's adsorption capacity. The adsorbent achieves 64.6 mg/g adsorption capacity after 60 minutes at a pH of 5 and at room temperature.

Keywords: Graphene oxide, Greener synthesis, Environmental impacts, Ibuprofen removal

INTRODUCTION

Ibuprofen, a commonly used medication for pain, fever, and inflammation, is categorized as a non-steroidal anti-inflammatory drug (NSAID). While generally deemed safe and widespread in use, ibuprofen has been identified as having negative environmental impacts, particularly concerning water resources. After ingestion, ibuprofen is excreted and eventually enters wastewater. Though water treatment plants are designed to eliminate contaminants, pharmaceuticals like ibuprofen often prove challenging to remove, potentially entering aquatic environments and harming aquatic life. Ibuprofen can detrimentally affect algae growth and survival, critical components of aquatic ecosystems [1]. Adsorption, a successful technique using materials like carbon nanomaterials, can remove ibuprofen from water effectively and sustainably. Factors like adsorbent properties and water conditions affect its efficiency. Continued research can enhance adsorption's effectiveness for treating ibuprofen-contaminated water [1].

Various adsorbents are available for ibuprofen removal from water, including activated carbon, zeolites, and minerals. Carbon nanostructures have garnered significant interest as eco-friendly adsorbents for removing ibuprofen, among various treatment techniques. Their distinct attributes, like their often large specific surface area, enable the efficient adsorption of pollutants. Moreover, they can be easily functionalized or modified using diverse nanomaterials and functional groups.

Notably, graphene oxide (GO) is gaining attention due to its unique properties and efficacy in eliminating ibuprofen from water. As a two-dimensional nanomaterial, graphene oxide's large surface area and functional groups make it an efficient adsorbent [3]. GO's regenerability makes it even more sustainable. Surface modification of GO with biopolymers offers benefits such as increased adsorption capacity, selective removal of pollutants, biocompatibility, stability, reduced leaching, and many tohers, making it an effective method for removing pharmaceutical pollutants from water. Through the surface modification of GO with biopolymer with diverse functional groups, the affinity of GO for polar pollutants can be elevated. Conversely, reduced GO (achieved *via* electrochemical techniques or natural reducing agents) can enhance its attraction to less polar pollutants. In addition, magnetizing graphene oxide with Fe_3O_4 enhances its usability as an adsorbent for water pollutants by simplifying separation, accelerating adsorption, enabling reuse, and improving overall pollutant removal efficiency.

METHODOLOGY

GO was fabricated based on the previous report [2]. For the preparation of the GO-gelatin nanocomposite, 2 grams of graphene oxide (GO) are dispersed in 200 mL of water, and 2 grams of biopolymer are added to 250 mL of water. The mixture is stirred at 75 °C for 24 hours and is subsequently subjected to separation techniques, including filtration, washing with water and ethanol, and drying at 65 °C, resulting in the GO-biopolymer nanocomposite. The synthesis of the GO-biopolymer nanocomposite involves co-precipitation of $FeCl_2 \cdot 4H_2O$ and $FeCl_3 \cdot 6H_2O$ in the presence of the GO-biopolymer.

RESULTS AND DISCUSSION

In order to validate the chemical composition and arrangement of the GO-biopolymer nanocomposite, a range of characterization techniques was utilized. This methodology includes the use of a scanning electron microscope (SEM). By employing these diverse approaches in conjunction, a comprehensive investigation of the synthesized GO-biopolymer nanocomposite structure was conducted, yielding a clear and comprehensive understanding. The dimensions and structure of the GO-biopolymer nanocomposite are assessed using a SEM image. The SEM depiction of the GO-biopolymer nanocomposite displays a morphology akin to the initially prepared GO, featuring crumpled layers. Observing the SEM images, it is evident that the Fe_3O_4 nanoparticles exhibit a consistently spherical structure when situated on the functionalized GO, comprising particles at the nanometer scale.

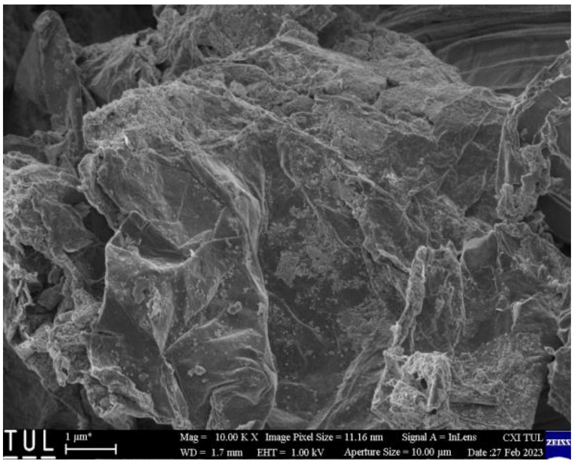

Figure 1: SEM image of GO-biopolymer nanocomposite.

According to Figure 2, this dataset illustrates the relationship between time intervals and adsorption capacity for a specific substance. The data points, collected at various time intervals, exhibit a significant increase in adsorption capacity. From the beginning, the capacity gradually increases to 64.6 mg/g after 60 minutes. This upward trend underscores a dynamic adsorption process. These findings hold significance in understanding what is the optimal time for the adsorbent to reach equilibrium with the surface of the adsorbate.

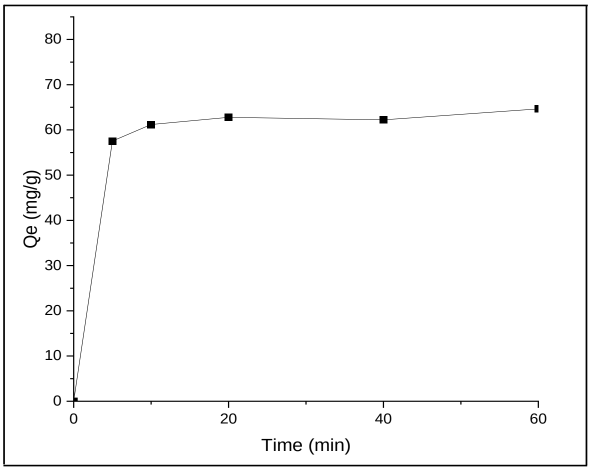

Figure 2: The effect of contact time on the adsorption capacity of the GO-biopolymer nanocomposite. Conditions: pH 5, contact time ranging from 0 to 60 minutes, 5 mg of adsorbent, room temperature.

CONCLUSION

In summary, in this study, a simple method for the fabrication of functionalized graphene oxide using biopolymer components and metal nanoparticles is presented. The chemical structure is confirmed through various analytical methods. The functionalized graphene oxide is then used to remove the Ibuprofen pollutant, studying its adsorption behavior under different condition such as time. The highest ibuprofen's adsorption capacity equaled 64.6 mg/g at pH 5 and room temperature.

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