



BIOMASS-BASED ADSORBENTS FOR REMOVAL OF DYES FROM WASTEWATER

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Abstract

The present work aims to explore the feasibility of employing an adsorption technique utilizing two readily available natural minerals, namely M1 and M2. The adsorbents were utilized for the treatment of actual textile wastewater samples taken from Fez city, Morocco, without undergoing any pretreatment or activation processes. Utilization of chemical oxygen demand (COD) and biological oxygen demand (BOD) parameters. Furthermore, an assessment was conducted to determine the impact of various operating circumstances, including contact time, adsorbent doses, and pH. The experimental findings indicate that the adsorption process exhibits rapid kinetics, achieving equilibrium between 90 and 160 minutes for M1 (with 88% COD removal) and M2 (with 79% COD removal), respectively. Both materials have a greater attraction for chromium (39%) and a lesser affinity for copper (28%). The experimental adsorption data is best described by a pseudo-second-order kinetic model. The results of the germination tests suggest that there is a low level of toxicity following the adsorption procedure. The performance of both materials was evaluated in comparison to previous studies documented in the literature.

Keywords: biomass, bio-adsorbent, conventional treatment techniques, dye removal, optimal conditions, removal efficiency

1. Introduction

Access to water of a quality that is adequate for human consumption is one of the most important problems facing the contemporary world today. The quality of the water is steadily deteriorating as a result of anthropogenic activities, uncontrolled urbanization, and expanding industrialization, all of which contribute to the problem. Many distinct kinds of manufacturing operations give off organic compounds that are commonly referred to as colors into the surrounding environment. (Piaskowski and colleagues, 2018). There has been a rise in the number of approaches and machines that can be used to treat contaminated wastewater. "Biological treatments, membrane processing, chemical/electrochemical technology, ion exchange, electrodialysis, electrolysis, and adsorption procedures" are only some of the treatment methods that are utilized on a regular basis.

Adsorption approaches (Dahri et al. 2014), photocatalytic oxidation, electrochemical oxidation, and chemical oxidation are some of the ways that have been developed to date in physical & chemical substrata to remove colored compounds from industrial effluents. Other methods include chemical oxidation and electrochemical oxidation. The adsorption method is thought to be more effective than other methods for removing dyes from aquatic environments (Yang and Qiu, 2010) because it is easy to execute, cheap, and highly efficient. This is especially true when the adsorbent is cheap and convenient to obtain.

Low-value biological materials, such as agricultural waste, are widely used as adsorbents in biosorption, a subcategory of the adsorption process (Bushra et al., 2021). Walnut Shell (WS) is a type of biological adsorbent found in the huge quantities of agricultural waste generated and disposed of each year throughout the world. Walnut shells are a byproduct of the food industry. The Food and Agriculture Organization (FAO) estimates that global walnut production in 2020 was around 3.3 million metric tons (containing both the kernels and the shells). According to FAOSTAT 2020, Iran's walnut production places it in third place worldwide and accounts for approximately 360 thousand tons. It is anticipated that global output of walnut shell trash will reach 2.3 million tons per year. This is due to the fact that walnut waste accounts for approximately 70% of the weight of walnuts, which includes both the inner and outer shell. This material's application as a "bio-adsorbent", in addition to removing dye from wastewater, will reduce agricultural waste, which is consistent with the concept of reuse in waste management strategies.

Dye adsorption kinetics by WS can be characterized by determining the shortest contact time at which the maximum adsorption rate is achieved. This may be done by comparing the initial dye concentration to the final dye concentration. After that, it follows a tendency that is best described as gradually ascending (Halysh et al. 2018). That is to say, once the experiment has begun, it takes just a short period of time to reach the conditions of equilibrium in the adsorption process (i.e., when the rates of adsorption and desorption are practically equal). This occurs due to the nearly identical adsorption and desorption rates. Despite this, a lot of smart people think the contact time is longer than it takes to get to equilibrium (Yang and Qiu, 2010). This is done in order to determine the minimal amount of time that is required to attain equilibrium. As a result, for the purpose of this investigation, a mixing speed of 150 revolutions per minute (rpm) and a contact time of 120 minutes (min) were used.

2. Methodology

The research study consisted of conducting a series of tests in three replicates using a batch methodology to examine the possible adsorption of WNS onto MB dye. To prevent unintended photochemical reactions from occurring due to exposure to sunlight, the batch adsorption studies were performed in dark brown bottles that had been wrapped in black paper. A beaker was filled with 50 milliliters of a methylene blue (MB) solution, which had a concentration of 50 milligrams per liter. Subsequently, 0.1 grams of adsorbent was added to the beaker. Afterwards, the residual concentration of MB was measured using a UV-vis spectrophotometer that was configured to a previously optimized wavelength of 665nm. The determination of the adsorption % of Methylene Blue (MB) was conducted utilizing the subsequent equation:

The present study investigated the impact of various parameters, namely pH (ranging from 2 to 10), dose (ranging from 0.1 to 1.0 gm.), and agitation speed (ranging from 50 to 250 rpm), on the percentage of MB. The isotherm and kinetic experiments were carried out by changing the concentration within the range of 50 to 200 mg/L, as well as varying the duration from 5 to 600 minutes. The studies were conducted under ideal circumstances of pH, velocity, and temperature. The study focused on investigating the effects of temperature, namely within the range of 30-50 °C, on the proportion of MB. Following that, the relevant numerical parameters and statistical uncertainties were determined for all of the conducted studies.

3. Analysis

When there is a negatively charged surface on the sorbent, and that surface is placed in an environment that is acidic, there is a larger likelihood that the adsorption of a cationic adsorbate will be improved. This is because cationic adsorbates have a higher affinity for negatively charged surfaces.

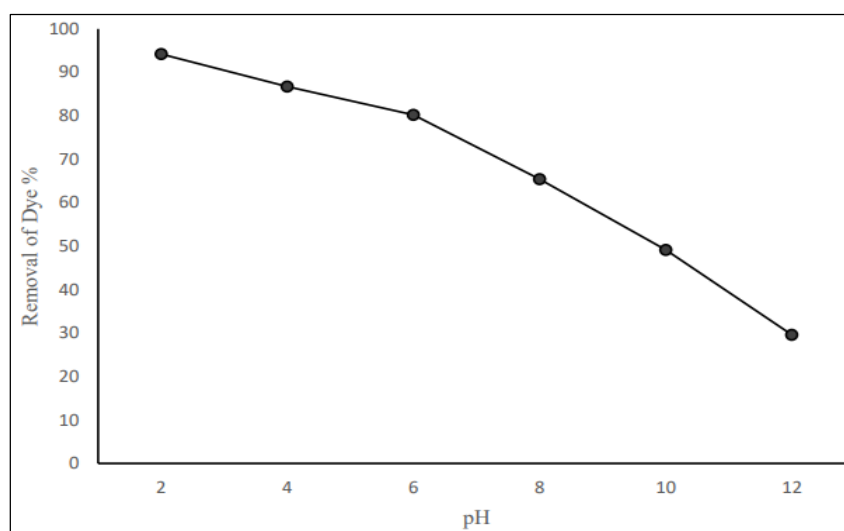


Figure 1: Effect of pH on dye adsorption.

There is a significant possibility that the longer time spent in contact may be responsible for the increased dye uptake that was observed. Because of this, there are more opportunities for interaction between the active sites and the adsorbate, which is essential for achieving the highest possible level of absorption.

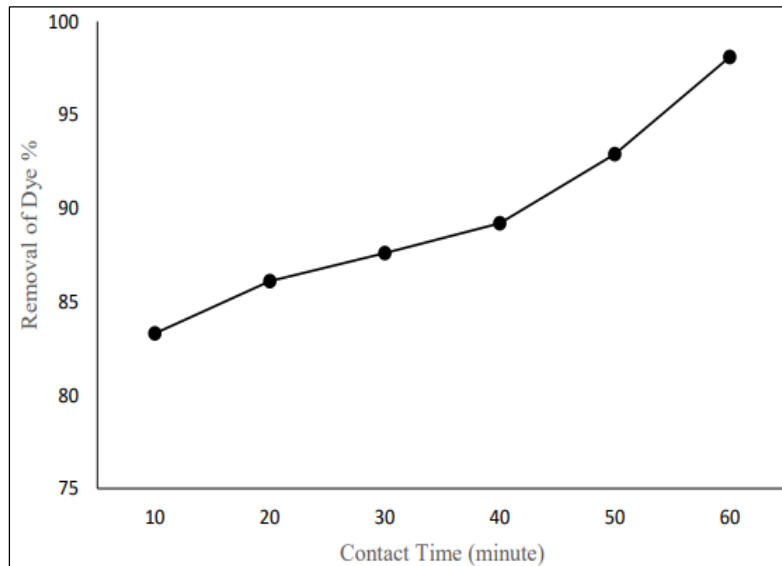


Figure 2: Effect of contact time on dye adsorption.

4. Conclusion

There was a focus on the various bio-adsorbents including fungi, forest, algae, yeast, bacteria, and agricultural wastes, but the review covered the removal and decomposition of dyes from wastewater utilizing traditional extraction techniques and biomass-based adsorbents in general. The analysis shows that standard dye treatment procedures have certain distinct drawbacks. Adsorption is an effective water and wastewater treatment technology due to its versatility, user-friendliness, and straightforward construction. Recent studies have shown that biomass-based treatments are the most effective adsorbents for removing dyes and other contaminants from a variety of applications. Dye-containing wastewater is a byproduct of the textile industry, and the majority of studies on biomass-based adsorption concentrate on the removal of a specific contaminant. Research into desorption is especially important since it helps to lower the cost of the process, recover the adsorbed substances, and reduce waste.

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