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The use of reed seed as adsorbent to remove methylene blue and congo red dyes from aqueous solution by adsorption

Ali K. Al-Muttairi

Environmental Research and Studies Center / University of Babylon, Iraq.
ORCID: https://orcid.org/0000-0002-9517-5203

*Corresponding author: allmankind10@gmail.com

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Abstract:

The present study was conducted as an attempt to find and inexpensive novel adsorbent that can be used to get rid of the dangerous. Throughout the study the ability of reed seed to get rid of both Congo red and methylene blue dyes was estimated. The newly proposed adsorbent showed a very high removal efficiency (R%) for both dyes with removal percentage up to 99% for the congo red and up to 72% for the methylene blue dyes, respectively. The reed seed as adsorbent was highly efficient in the removal of the days at different concentrations (from 10 to 50 ppm) with R% range from 94 to 96 % for methylene blue and from 22 to 72 % for congo red, while the highest R% for methylene blue was 96 at pH 7, and it was 72% at pH 5 for the congo red.

Keywords: Reed seed, adsorption, Methylene blue, congo red

Introduction

With the advance in industry there is an increase in the waste resulted from these industries, one of these ever-growing pollutants are dyes, which can be toxic, resistant and hard to remove from water [1]. Many dyes are presented in the dyeing industries effluent including methylene blue, congo red and eosin y together with many other dyes. The Congo red (CR) is consider as azo dye which is resistant to decolorization and can give a different degree of coloring which made it a favorable in the fibers dying industry, but on the other hand it considered as carcinogenic dye and hazard to humans as well as the environment [2]. While the methylene blue (MB) is a cationic, thiazine dye that been utilized primarily in medicine as well as in dying of paper and textile. It can cause several health issues to humans [3].

Many methods can be used for the removal, degradation or break down of dyes, in general they are been classified according to their mode of action into three classes: physical methods for example the membrane filtration and adsorption, chemical methods such as coagulation and biological methods such as phytoremediation [4]. Adsorption is considered as an efficient practical application to eliminate dyes with a variety of materials as possible adsorbent ranged from activated carbon, clay and different types of plants and fruits waste [5]. There are a lot of studies that deal with the subject of eliminating harmful and persistent dyes through the application of adsorption technique [6, 7, 8, 9, 10]

In order to find out the ability of the newly proposed, cheap and available adsorbent (reed seed) as a novel adsorbent to remove two widely spread dyes MB and CR dyes.

1. Materials and contaminants

CR and MB dyes were used in this study. The standard solution was prepared by dissolving the dye (as powder) in the D.W. to prepare a standard solution (100 ppm) and then the required concentration was prepared according to the dilution equation (1).

$$N1V1=N2V2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The adsorbent used in this study was the reed seeds which was first collected from agricultural land and then dried, after that it was grinded by electrical grinder to fine pieces and then kept in dry container tile it was used.

Experiments

Four experiments were carried out to evaluate the capability of the newly proposed adsorbent (Reed Seed) for the removal of both dyes [11, 12]. At first the optimum time for contact between the adsorbent and the dye was estimated. eight samples each with 20 ppm dye concentration , and a sample volume of 50 ml was set in conical flasks then 0.75 gm of the adsorbent was added to each sample, the samples then kept in the shaker for consecutive contact time of (10, 20, 30, 40, 50, 60, 90, and 120 min.), respectively. The 2nd experiment was carried in order to figure out the consequences of changing the concentrations of dye presented in the solution on the adsorption process. Five samples each with sample volume of 50 ml and various initial dye concentrations (10, 20, 30, 40, as well as 50 ppm), respectively were kept in conical flasks and 075 gm of the adsorbent was added to each sample, then they were transfer to shaker for 40 minutes for the congo red dye and for 50 minutes for methylene blue dye, respectively.

The third experiment was executed for finding out the consequences of altering the adsorbent dosage on the overall outcome of the adsorption. Five samples each with 20 ppm dye concentration, and a sample volume of 50 ml was set in conical flasks then a series of adsorbent dose of (0.25, 0.5, 0.75, 1, and 1.25 gm) after that samples were transfer for shaker for 40 and 50 minutes for CR and MB dyes, respectively. The 4th experiment was done to determine shift in the adsorption process with the change in the solution pH. Three samples each with 20 ppm dye concentration, and a sample volume of 50 ml was set in conical flasks with pH value of 5, 7, and 9, respectively. Then 0.75 gm of the adsorbent was added to each sample and transfer to shaker for 40 and 50 minutes for congo red and methylene blue dye, respectively.

Then the samples collected from each experiment was transferred to the centrifuge for 4 minutes and with 5 thousand RPM. Then the supernatant was collected, the samples absorbance was calculated by using the UV /Visible Spectrophotometer (Japan). Then the removal efficiency was measured by applying the following equation:

$$\text{Removal Efficiency (R) \%} = \frac{\textit{intial concentration} - \textit{sample concentration}}{\textit{initial dye concentration}} * 100 \text{.....(2)}$$

Results and Discussion

In this study the ability of reed seed to act as adsorbent was tested. At first the optimum time for adsorption was tested, the adsorbent display different affinity for these dyes and subsequently in the dye removing ability, as shown in the Figure 1.

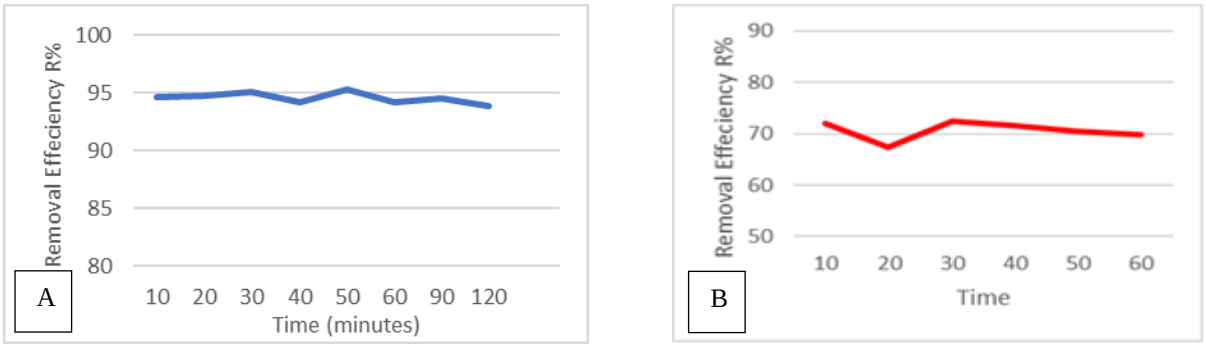

Figure 1:The best contact time between **A)** methylene blue dye . **B)** congo red dye

As shown in the figure 1 the proposed adsorbent show very high rate of removal for both dyes but it was more efficient in removing the methylene blue than the congo red dye. the best contact time metheylene blue, and congo red dyes removal was 50 and 10 minute, respectively. While the best R% for congo red was reached at much higher and faster that the findings of Kasthuri *et al.*[13] who found that the best removal of congo red was 85% at 50 minutes, and R% was higher for the methylene blue dye that the result of [14] how found that best contact time was 50 minutes with R% = 80 %. After setting the best contact time for dye removal, the dose of the adsorbent effect was tested, the results are shown on the figure 2. For the methylene blue it was show a fluctuation in the dye removal effcieny but the over all outcome show a dirrect relationship between the increase in the R% and rasinig the adsorbent dose, while for the congo red it was a direct

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correlation between the R% and the adsorbent dose tile reaching the equilibrium. That could be attributed to that with the increase in the adsorbent the available active surface causing an elevation in the removal effciency [15]. The results agree with the finding of Nitayaphat *et al.*[16] who found that the there was an increase in the removal of MB dye with the increase in the adsorbent wight from 1 gm to 3 gm, respectively. While it disagree with findings of Ezeugo [17] who found that it increase with the increase in the adsorbbent dose and then decrease with the further raise in the adsorbent dose.

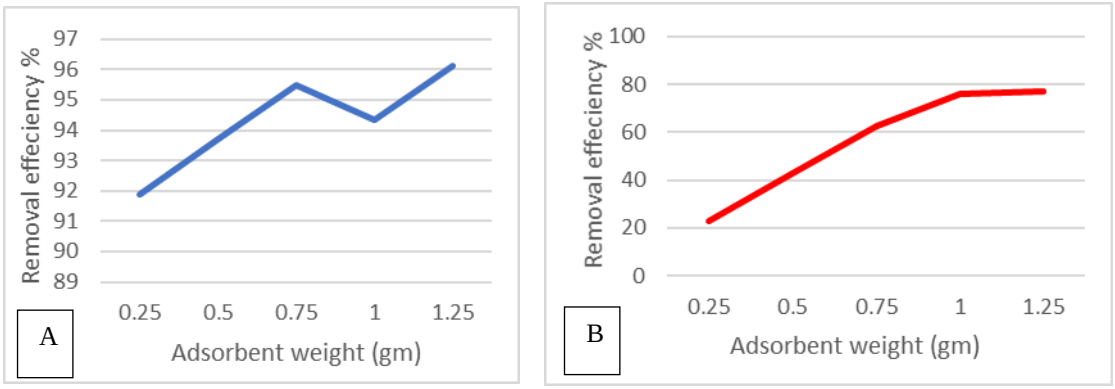

Figure 2: Effect of the adsorbent dose on the adsorptin process of, **A)** Methylene Blue dye, **B)** Congo Red dye

The results indicate that there was an increase in the R% of both CR and MB dye as the starting dye concentration increase from 10 to 50 ppm as shown in Figure 3, A and B. that is due to the increase in dye concentration there was a rase in the kinetic energy as the dye molecules travels from the solution to the adsorbent [18], or it can be linked with the quantity of the dye molecules presented in the solution and ready for adsorption which increased dye removal efficiency. The study results are aligned with the findings of [17, 19].

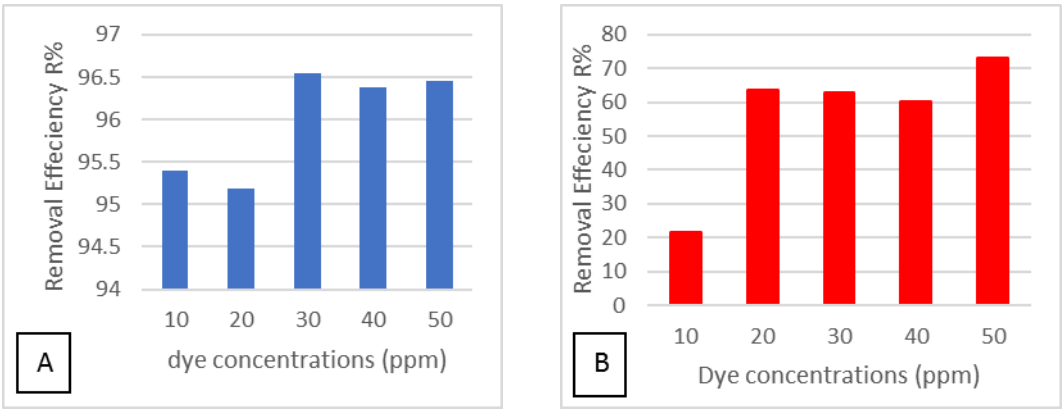

Figure 3: the effect of the initial dye concentration on the adsorption process of **A)** methylene blue dye, **B)** congo red dye

The pH of the solution affect the adsorption significantly, for MB the highest removal efficiency was at pH 7, followed by pH 5 and the lowest at pH 9, but at all pH value the adsorbent was highly effective in removing the MB dye, that can be explain by the fact that with the raise in pH value can reduce as shown in Figure 4. The protonation in the dye and the sulfonate groups can engage with the active sites in the adsorbent , that with the engagement of the van der Waals which cause the decrease in the R% of the CR dye with the increase in the pH value of the solution [20], the results of this study are in alignment with the finding of Seidmohammadi *et al.*[21]. while for the congo red dye the highest R% was at pH

5 and its lower its removal efficiency as the pH value of the solution increase up to 9, and that can be understood since that as the pH value increase the amount of the H^+ ions increase which will compete with dye ions and subsequently decrease the dye adsorption [22], the results are aligned with the results of Ghati *et al.*[23] who found that the congo red dye removal decrease as the pH value increase up to 10.

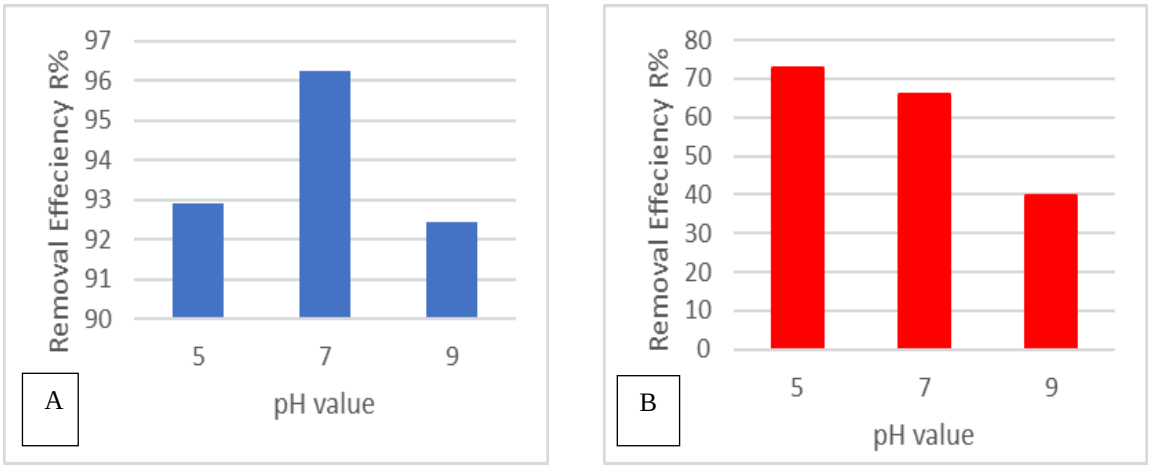

Figure 4: The effect of the solution pH on the adsorption process of **A)** methylene blue dye, **B)** congo red dye.

Conclusions

The results of this study show a great potential for the reed seed to be used as adsorbent for the used dyes and modification such as using activation or preparing a nano material form these seeds can improve it ability in a future work.

Author Contributions Statement

The author is responsible for the experimental work, writing and publishing the papers.

Declaration of competing interest

The author declares that there is no conflict of interest

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