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Study the Efficiency of Processed Walnut Bark Powder for Methylene Blue Color Removal from Aqueous Solutions

Ali Almasi[1], Mitra Mohammadi[1], Zahra Atafar[1], Ali Azizi[2], Farhad Amirian[3] and Abdollah Dargahi[4]

[1]*Department of Environmental Health Engineering, School of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran*
[2]*Social Medicine Specialist, Assistant Professor of Social Medicine, Faculty of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran*
[3]*Pathology Assistant, Faculty of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran*
[4]*Department of Environmental Health Engineering, School of Health, Hamadan University of Medical Sciences, Hamadan, Iran*

ABSTRACT

Color is one of the most important contaminant factors of wastewaters such as textile, leather, dyeing and plastic industries, cosmetics, paper and paint industry and food industries. Present study was conducted with the aim of evaluating the efficiency of processed walnut bark powder for methylene blue color removal from aqueous solutions. The study was experimental- intervention type. In the study, initially walnut bark samples were milled and then sieved and 80×360 µm particles were separated and collected. In order to removing impurities, milled samples were rinsed several times by sodium bicarbonate detergent, 0.1 N HC and distilled water and dried at 105°C for 2 hours. For measuring absorption amount and color concentration spectrophotometric method was utilized at 663nm. Results showed that removal percent of methylene blue dye increased by increasing in dye initial concentration and contact time. Absorption data for studied absorbent follows Freundlich model with regression coefficient of R^2= 0.93. Processed walnut bark powder as an inexpensive and possibility to preparation in different conditions could be utilized as strong absorbent for water and wastewater treatment. Strength of the present study could be utilization of inexpensive and easy biotechnology for environmental pollution.

Keywords: natural absorbent, walnut bark, methylene blue dye, aqueous solutions

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INTRODUCTION

Color is one of the most important contaminant factors of wastewaters such as textile, leather, dyeing and plastic industries, cosmetics, paper and paint industry and food industries **[1]**. Discharged dye compound from these industries is very dangerous and has great environmental problems**[2]**. Dye materials of industrial wastewaters are considered due to toxicity for aquatic organisms, distortion of efficiency in common water treatment systems and aesthetic aspects. Since colored wastewaters of industries in receptor water results to eutrophication phenomena and interference with waters ecology, so even total pollutants were removed from water, residual dyes environmentally are very important which depends on dye type and its concentration **[3, 4]**. In terms of health issues, dyes have carcinogenesis and mutagenesis property and could result to allergy and skin problems. Dyes are generally have

aromatic complex molecular structure. Presence of these compounds in industrial waste waters impaired biological processes due to very little biodegradability. Most of dyes are stable against light and heat, on the other hand, technologies which increase their resistance to bleaching agents, sunlight and oxidation, caused to no separation of them from usual treatment systems **[5, 6]**. Therefore, bleaching is one of the prominent aspects of wastewater treatment prior to discharge to the environment. Dyes removal from wastewater is difficult because of their late degradability and usually could not be removed through common treatment systems. Usually, aerobic biological systems were not successful for wastewaters bleaching. Common ways for dyes removal include coagulation and flocculation, oxidation or ozonation, ultrafiltration, electrochemical sorption, membrane separation, ion change as absorption process **[1]**.

However, these methods generally were not utilized due to high cost and being uneconomic. Chemical and electrochemical oxidation and coagulation are not practical in industries in large scale. In contrast, sorption method mainly utilized for dye removal from wastewaters **[7]**. The most common absorbents include silica alumina **[8]**, metal hydroxides, bentonite soil, cellulose phosphohydrate, coke, Chinese soil and granular-powdered activated carbon. Among various absorbents, activated carbon is one of the most effective materials which used for dye sorption. Since processing and rehabilitation of activated carbon is expensive and some parts of activated carbon wasted at various stages of restoration, researchers are attempting to find novel and inexpensive absorbents and many studied are conducting for developing low-cost absorbents applications **[9]**.

In the present study, a low cost absorbent called processed powder of walnut bark was used for methylene blue dye removal. Although this dye has no serious danger, but the interested dye was accepted as an index in regard to dye removal. Accordingly, the aims of the study were to determination of sorption isotherms, effect of concentration and contact time on removing methylene blue using processed powder of walnut bark from aqueous solutions.

MATERIALS AND METHODS

The study was experimental- intervention type. In the study, initially walnut bark samples were milled and then sieved and 80×360 µm particles were separated and collected. In order to removing impurities, milled samples were rinsed several times by sodium bicarbonate detergent, 0.1 N HC and distilled water and dried at 105°C for 2 hours. Methylene blue removal using walnut bark studied in discontinuous system at different contact times. In order to determination of absorbent pH, 5 g/l sample prepared in distilled water and preserved in laboratory conditions for 24 hours. Then pH values of solution at 3-8 range read by pH-meter at six levels. In order to determination of the efficiency of processed powder of walnut bark in methylene blue removal, initially 5 flasks containing 100ml 0.1 mg/l methylene blue solution added to each flask. Then, 1, 2, 3, 4 and 5 g/l absorbent respectively added to flasks No. 1 to 5 and stirred for 10 min at 300 rpm. After 10 min, flasks containing separately filtered by Watman filter paper and filtered solution transferred into tubes. After transferring solutions on filter paper, flasks were stirred for 10 min again. After second stirring, flask containing were filtered. Similar steps were repeated for third, fourth and fifth 10 min (30, 40 and 50 min) and flasks residual solutions were filtered. Finally, absorption of 25 tubes measured by spectrophotometer Shimadzu Model UV-120-02 at 663 nm. In order to processing walnut bark, five dye concentrations (100, 200, 300, 400 and 500 mg/l) were utilized. Each experiment had three replications and mean of measurements were reported as final result. Approximate analysis of utilized walnut bark components include cellulose (36.9%), hemi-cellulose (17.9%), lignin (24.8%), extractable compounds (8.8%) and moisture (9%).

In the present study, effect of various parameters such as proper contact time, absorbent dose and different concentrations of dye were studied. After determination of proper contact time and absorbent dose, properties related to absorption isotherm on processed powder of walnut bark were determined. Absorption isotherms were studied using Freundlich and Longmuir equations.

RESULTS

Results of the study presented in Tables 1 to 3. Effect of pH on methylene blue removal rate studied (Fig. 1). As can be seen in Figure 1, methylene removal percent affected by solution pH and by increasing pH from 3 to 6 methylene removal increased on absorbent surface and at higher pH values removal rate decreased. So, pH value of 6.5 was selected as optimum pH for the afterward experiments. After pH optimization, absorbent and methylene blue solution contact time was optimized. At constant pH value of 6.5 and 1 g/l absorbent amount, and methylene blue concentration of 100-500 mg/l, the effect of contact time on removal rate studied at 10-50min time range. The study

showed that by increasing contact time from 10 min to 50 min, methylene removal rate increased, so that highest removal rate for powder obtained as 51.4 percent at 50 min contact time and 500 mg/l methylene and the lowest amount by 28.4 percent obtained in 10 min contact time and 100 mg/l methylene (Fig. 2). In order to study the effect of absorbent dose on methylene blue removal, various amounts of absorbent exposed to 100-500 mg/l methylene blue solution (Fig. 3). Results showed that increasing absorbent dose from 1 to 5 gr resulted to increase in methylene blue removal so that highest removal by 63.54 percent obtained in 5gr and 500 mg/l methylene blue and lowest amount obtained by 1 gr absorbent and 100 mg/l nethylene blue solution as 16.8 percent.

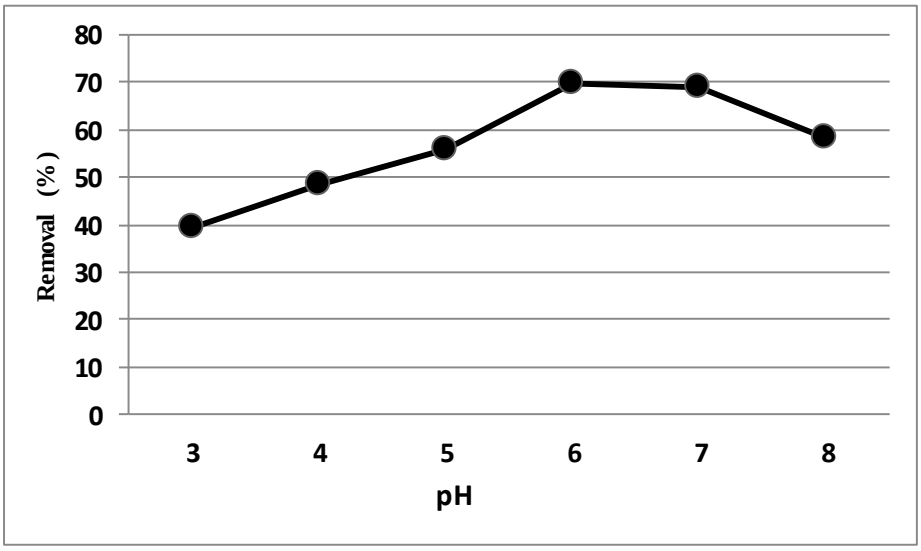

Figure 1- Effect of pH on methylene blue removal through studied

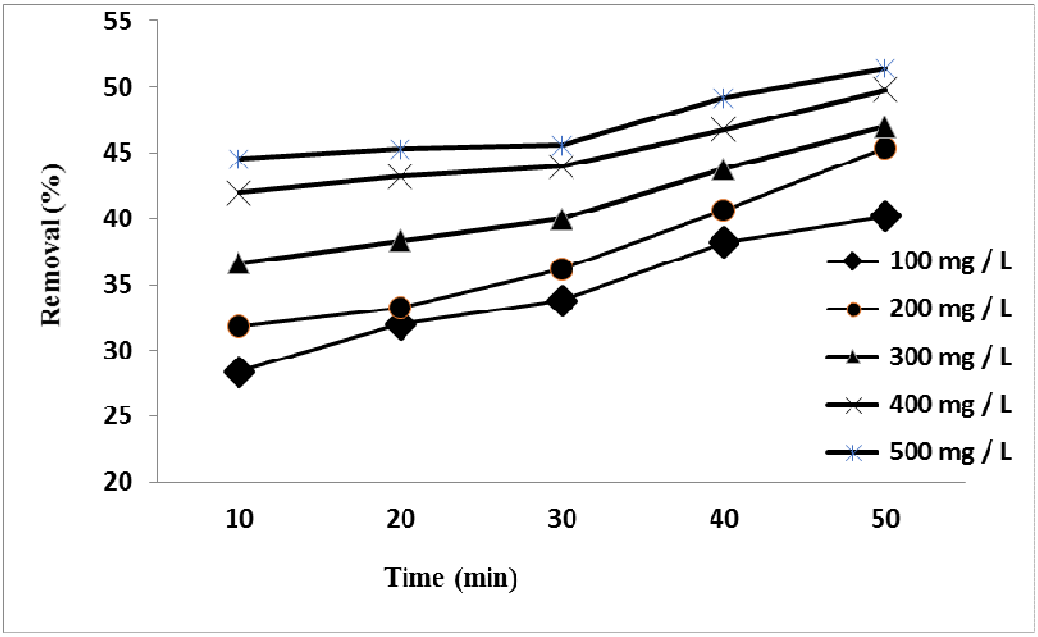

Figure 2- Effect of contact time on methylene blue removal through studied

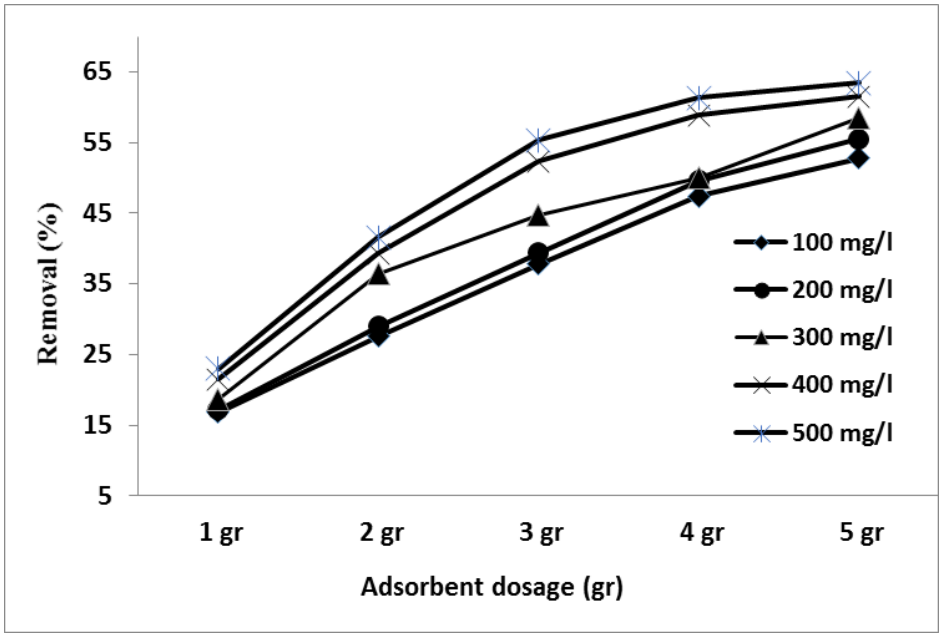

Figure 3- Effect of absorbent dose on methylene blue removal through studied absorbent

Absorption isotherms are mathematical equation for explaining the equilibrium state of absorbate between solid and liquid phase. Experimental data for absorption equilibrium were studied by Freundlich and Longmuir absorption isotherms. Results showed that methylene blue absorption on studied absorbent follows Freundlich isotherm (R^2= 93%).

DISCUSSION

pH is one of the important factors which affect absorption process through effect on dye structure and surface charge. According to results, by increasing pH values, dye absorption increased, so that at pH of 6.5, methylene blue dye absorption on processed powder of walnut bark performed with proper efficiency. Results are in consistent with other studies. Ong et al. (2007) reported that reactive dyes absorption percent on rice bran increased by increasing pH. These authors reported that at low pH amounts, absorbent surface surrounded by proton containing carboxylic factors and prevents appropriate dye absorption. This event is evident for studied absorbent **[9]**. Hameed et al. (2007) studied AG25 dye absorption on palm activated ash at 2-13 pH values and reported that by increasing pH, dye absorption decreased because of increasing OH anion and change in surface charge. Although apparently the results of present study are different form Hammed et al. (2007) findings, but basically effect of pH on dye absorption completely equal. Therefore according to results of the present study and other ones in can be concluded that considering to effect of pH on surface charge of pollutant and absorbent utilized for treatment, effect of pH must be evaluated specifically **[10]**. As can observed from results, dye removal efficiency increased from 16.8 to 63.45 percent as absorbent dose increased and removal reached to maximum amount at 5 absorbent dose. Increase in methylene blue removal by increasing absorbent dose results from increasing active and efficient surface area for absorption. The results confirmed by Ong et al. (2007) **[9]**. According to results, removal percent increased by increasing initial concentration of the dye and maximum removal percent observed at 500 µg/l by 63.45 percent. Results are in consistent with Mehmet et al, results **[11]**.

The effect of contact time for processed powder of walnut bark on methylene blue removal percent was studied at 500-100 µg/l. removal percent increased by increasing contact time which are in good consistence with Yamin yasin et al. results who studied methylene blue removal by activated carbon at 50 to 100 ppm. Results showed that contact time had prominent contribution in methylene blue removal, which was due to strong bindings between dye molecules and absorbent by increasing contact time **[12]**.

CONCLUSION

Overall results of the present study showed that processed powder of walnut bark could have many applications due being inexpensive than activated carbon and no need to activation step, higher physical resistance compared to activated carbon and easy accession to required primary materials and ability to remove various pollutants. Strength of the present study could be utilization of inexpensive and easy biotechnology for environmental pollution. Also results showed that methylene blue removal efficiency increased by increasing contact time, initial concentration of dye and absorbent dose.

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