Asian Journal of Chemistry; Vol. 23, No. 9 (2011), 4183-4185

ASIAN JOURNAL OF CHEMISTRY

www.asianjournalofchemistry.co.in

Sorption Potential of *Litchi chinensis* for Aqueous Metanil Yellow Solution

SHAFIQ-UR-REHMAN[1,*], AHMAD ADNAN[1], SAMINA SHAHID[2], FAHIM A. QURESHI[1], IFTIKHAR AHMAD[1] and HAFIZA FAIZA SHAMSHEER[1]

[1]Department of Chemistry, Government College University, Lahore-54000, Pakistan
[2]Institute of Chemistry, University of The Punjab, Lahore, Pakistan

*Corresponding author: Tel: +92 333 4566845; E-mail: shafiqchemist@gcu.edu.pk

(*Received*: 12 January 2011; *Accepted*: 27 May 2011) AJC-9995

Litchi chinensis stem bark was used as biosorbent for the removal of metanil yellow from aqueous solution. Biosorbent was washed with 80 % methanol and hot tap water respectively and then activated by boiling with 6 N HCl. After activation biomass was washed several times with distilled water and dried at 80 ºC over night. Different parameters such as initial pH, dye concentration, sorbent dosage, ion strength, particle size and time period were studied. pH 2 was found optimum for this study. Metanil yellow were removed 97.6 % at pH 2.0. Langmuir model was applied on the isothermal data for biosorption. FTIR spectra showed that amino group adsorbed the dye thorough the electrostatic attraction between the positive charge of dye and negative charge of biosorbent.

Key Words: *Litchi chinesis*, Biosorption, Anionic dyes, Agricultural by products, Waste water treatment.

INTRODUCTION

Many industries, such as paper, plastics, food, cosmetics, textile, *etc.*, use dyes in order to colour their products. The presence of these dyes in water, even at very low concentrations, is highly visible and undesirable[1,2]. Colour is the first contaminant to be recognied and environmental regulations in most of the countries (EU directive 91/271) have made it mandatory to decolourize the dye wastewater prior to discharge[3]. Many dyes are difficult to degrade due to their complex structure and xenobiotic properties. Decolourization of textile dye effluent does not occur even if the effluent is treated by municipal wastewater treatment systems[4].

The presence of dyes in water reduces light penetration and has a derogatory effect on photosynthesis. Dyes may also be problematic if broken down anaerobically in the sediment, leading to the production of toxic amines. Lethal levels may be reached affecting aquatic systems and associated flora and fauna. Many treatments have been investigated regarding their effectiveness in either removing the dyes from dye-containing effluent, or decolourising dyes through liquid fermentations[5].

Currently, the most widely used and effective physical method in industry is activated carbon, although running costs are expensive. This is mainly due to the chemicals required for regeneration after dye removal [6]. Although activated carbon removes dyes from solution, they are then present in a more concentrated and toxic form and so their safe disposal increases the costs further. Therefore, the potential exists for the process of dye removal by adsorption to be more economically feasible by looking at the use of lower cost biosorbents.

Since the formation of the Ecological and Toxicological Association of the Dyestuffs Manufacturing Industry (ETAD), in 1974, measures have been taken to minimise environmental damage[7].

This study was done to investigate the use of a *Litchi chinensis* for Metanil yellow dye removal by adsorption. The aim of the study is to develop low-cost adsorbents for an inexpensive dye-removal technology. The effects of both the varying concentration of the dye effluent and the particle size of the substrates on dye removal were investigated.

EXPERIMENTAL

Preparation of biosorbent: The stem bark of *Litchi chinensis* was collected from bank of Ravi river of Lahore, Pakistan, extensively washed with tap water to remove soil and dust. The dried powered biomass was washed with methanol and then with boiling water several times. The plant material was activated with HCl (6 N) and was stored in desiccator after washing with distilled water for experiments.

Preparation of anionic dye solutions: The dye stock solution of Metanil yellow was prepared of concentration 200 mg/L. The experimental solutions were obtained by diluting the dye stock solutions in accurate proportions to different initial concentrations.

Experimental methods and measurements:Biosorption experiments were carried out in a rotary shaker at 150 rpm and temperature was kept at 30 ºC using 250 mL shaking flasks containing 100 mL of different concentrations and initial pH values of dye solutions. The initial pH values of the solutions were previously adjusted with 0.1 M HNO_3 or NaOH. Different doses of sorbent were added to each flask and then the flasks were sealed to prevent change in volume of the solution during the experiments. After shaking the flasks for predetermined time intervals, the samples were taken out from the flasks and the dye solutions were separated from the sorbent by filtration with Whatmann filter paper No. 41. Dye concentrations in the supernatant solutions were estimated by measuring the adsorbance at maximum wavelengths of dyes with a Cecil-7200 double beam UV/VIS Spectrophotometer and computing from the calibration curves. The amount of dyes sorbed by the biomass was calculated using the following equation:

$$q = (C_0 - Ce)V/W$$

where q (mg/g) is the amount of dye sorbed by biomass, C_0 and Ce (mg/L) are the initial and equilibrium liquid phase concentrations of the dye, respectively, V (L), the initial volume of dye solution and W (g), the weight of the biomass.

Fourier transforms infrared analysis: The infrared spectra of the biosorbent samples in KBr discs were analyzed using a fourier transform infrared spectrometer (MEDIAC-2000, USA), within the range 4000-400 cm^{-1}, to identify the functional groups responsible for the biosorption.

RESULTS AND DISCUSSION

Effect of initial pH: To check the effect of pH on biosorption of Metanil yellow by the stem bark of *L. chinensis*, different pH values was used (2.0 to 12.0). The dye removal ratio was highest at the initial pH 2.0. The ratios of dyes sorbed decreased as the initial pH was increased from 2.0 to 5.0 and it kept constant beyond pH 5.0 (Fig. 1). For this reason, pH 2.0 was selected for all other experiments.

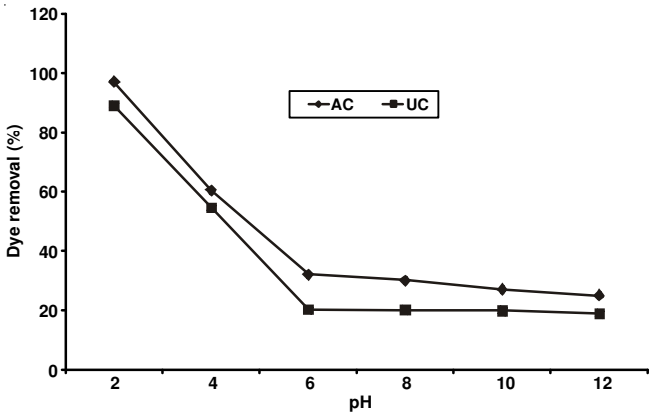

Fig. 1: Effect of pH on biosorption.

Initial dye concentration: To study the effect of dye concentration on biosorption process, various dye concentrations were used. As shown in Fig. 2, when the dye concentration was increased from 10 to 100 mg/L, the percentages of dyes sorbed

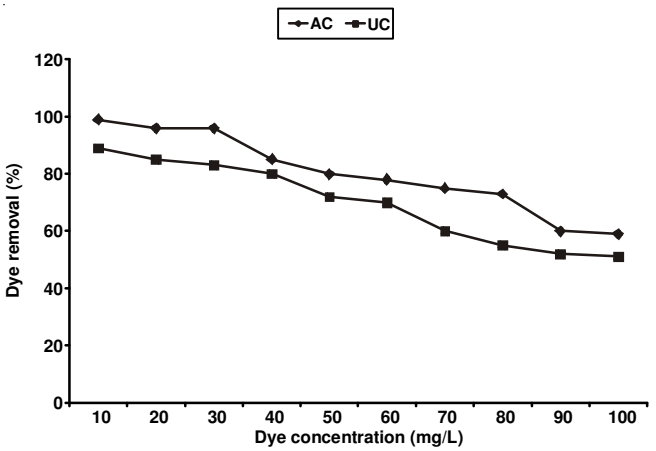

Fig. 2: Dye concentration

decreased from 99 to 59 % and 89 to 51 % for activated (AC) and unactivated (UC), respectively. The Langmuir equation was employed to study the sorption isotherms of dyes.

The Langmuir equation is shown as follows:

$$Ce/qe = 1/(aQm)+Ce/Qm$$

where Ce (mg/L) is the concentration of the dye solution at equilibrium, qe (mg/g) is the amount of dye sorbed at equilibrium, Qm is the maximum sorption capacity and a is the Langmuir constant. The Qm (69.3 mg/g) and a (0.012) values were calculated from the slopes (1/Qm) and intercepts (1/aQm) of linear plots of Ce/qe *versus* Ce.

Effect of sorbent dose: The sorbent dose has great effects on the removal of dyes are shown Fig. 3. The percentages of dyes sorbed increased as the sorbent dose was increased over the range 1-10 g/L. The biosorption ratios of dyes increased from 42 to 98 and 33 to 90 % for activated and unactivated, respectively and increase in biosorption with the sorbent dose could be attributed to increased surface area and the availability of more sorption sites.

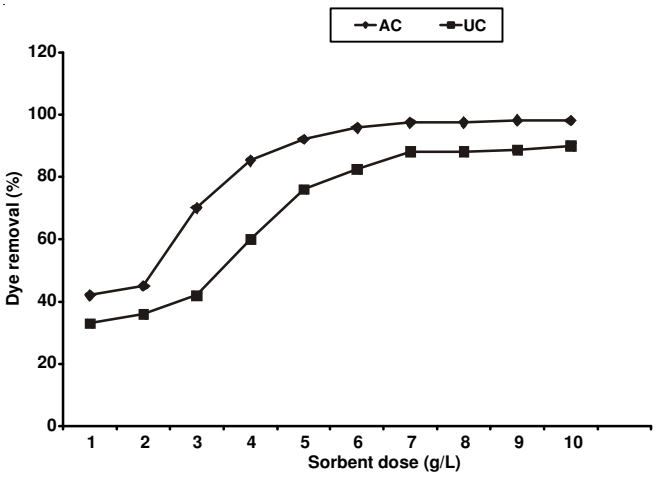

Fig. 3: Sorbent dosage

Influence of sorbent particle size: To check the effect of particle size of the biomass on removal of dye, different particle sizes of the biosorbents were used. The ratios of dyes sorbed increased as the sorbent particle size decreased, but the ratios of dyes sorbed had approached the maximum values

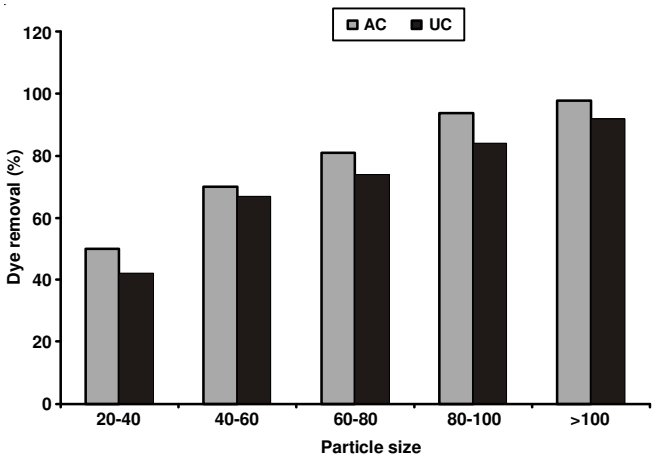

Fig. 4: Effect of particle size on biosorption

in both activated and unactivated when the sorbent particle size is greater over 100 meshes.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Durre Shahwar for technical assistance and HEC, Pakistan for financial supports in this study.

REFERENCES

1. K.R. Ramakrishna and T. Viraraghavan, *Water Sci. Technol.,* **36,** 189 (1997).
2. P. Nigam, G. Armour, I.M. Banat, D. Singh, R. Marchant, *Bioresour. Technol.,* **72,** 219 (2000).
3. C. O'Neill, F.R. Hawkes, N.D. Lourenco, H.M. Pinheiro and W. Delee, *J. Chem. Technol. Biotechnol.,* **74,** 1009 (1999).
4. N. Willmott, J. Guthrie and G. Nelson, *J. Soc. Dye Colour,* **114,** 38 (1998).
5. I.M. Banat, P. Nigam, D. Singh and R. Marchant, *Bioresour. Technol.*, **58**, 217 (1996).
6. T. Robinson, G. McMullan, R. Marchant and P. Nigam, *Bioresour. Technol.,* **77**, 247 (2001).
7. R. Anliker, *Ecotox. Environ. Safety*, **3**, 59 (1979).