ADSORPTION OF METHYLENE BLUE DYE BY PISTACHIO SHELLS

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1 INTRODUCTION

Nowadays, environmental pollution can be identified as one of the major problems of developed and developing countries. Dyes contribute to pollution, since they are, generally, present in effluents from textile, leather, food processing, cosmetics and paper industries (Robinson *et al*, 2002).

In response to concerns over water pollution, by those textile industries responsible for the discharge of large amounts of dyes in effluents, several physical or chemical methods have been developed in order to remove the color (Allen *et al*, 2003; Nigam *et al*, 2000; Al-Degs *et al*, 2000). Among these methods of dye removal, the adsorption method is the most effective in treating such effluents.

The solid-liquid adsorption technique, by using low cost adsorbents, shows promising results in removing colored substances from textile effluents (Mohan *et al*, 2002). The most popular adsorbent is activated carbon; however, due to its high cost and the need of regeneration, other materials have been studied and used in its place (Malik, 2003; Al-Ghouti *et al*, 2003). Many of these materials come from industrial and agricultural wastes or are directly found in nature.

This study aimed at evaluating the adsorbent potential of pistachio shells in studies of removal of dyes, using methylene blue (MB) as a dye model.

2 MATERIALS AND METHODS

2.1 Preparation of adsorbent and dye solution

Samples of pistachio, traded in Cascavel city, were purchased, opened, their shells washed with distilled water, dried at 60 °C, ground and sieved (grain size < 1 mm).

A methylene blue (MB) dye reserve-solution was prepared at a concentration of 1500 mg L^{-1} (4.0 mmol L^{-1}) in distilled water. The other solutions used in this trial were prepared by diluting the reserve-solution with distilled water. All adsorption experiments were carried out at 25 ^{o}C.

2.2 Kinetics and isotherms of adsorption

To study the effect of contact time on dye adsorption, 0.100 g of adsorbent was put in contact with 50 mL of MB solution (10 μmol L^{-1}) and stirred for 12 hours, at room temperature. In periods of pre-determined time, aliquots were taken, diluted and centrifuged for 3 minutes at 3000 rpm. Dye concentration in the supernatant was analyzed by a spectrophotometer UV-Vis (λ_{max} = 665 nm). In order to calculate the dye concentration, a calibration curve was determined for methylene blue dye, whose concentration values ranged from 0.25 to 5.0 μmol L^{-1}.

In the experiments of adsorption isotherms, samples containing the adsorbent were put in contact with a solution (50 mL) of MB dye in several concentrations and stirred at a constant rate until they reached the adsorption equilibrium. Aliquots were taken, properly diluted in volumetric flasks and centrifuged for 3 minutes at 3000 rpm. The MB dye concentration in supernatant was analyzed as previously described. The adsorbed amount of MB dye (q) by pistachio shells was calculated from the difference between the initial and final concentration of MB dye in solution and the mass of adsorbent.

3 RESULTS AND DISCUSSION

The calibration curve, a plot of instrument response vs. analyte concentration for MB dye analyses, showed a good linear relationship whose equation and linear correlation coefficient (R) are presented in Figure 1.

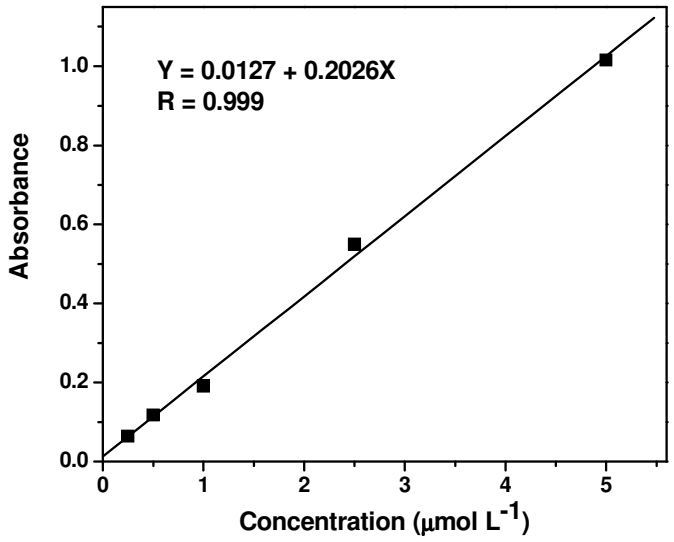

FIGURE 1 **Calibration curve for the methylene blue dye solution.**

The kinetics of MB dye adsorption by pistachio shells is represented in Figure 2. The results showed that the decrease of MB concentration is fast in the first minutes, probably because of an excess of adsorbent with available sites of adsorption on their surface, able to bind themselves to MB. The equilibrium was reached in about 90 minutes and was constant up to 10 hours. The reduction of the MB dye concentration, in the presence of pistachio shells, after reaching the equilibrium, was approximately 74%.

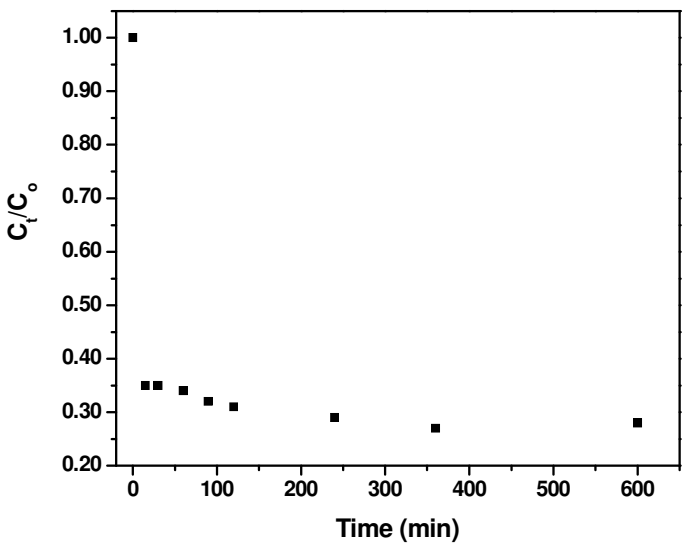

FIGURE 2 **Kinetics of methylene blue dye adsorption by pistachio shells.**

Figure 3 shows the amount of MB dye adsorbed in pistachio shells at equilibrium (q_e), as well as the equilibrium concentration of this dye in the aqueous phase (C_e). It can be observed that the amount of MB dye adsorbed increases with the dye concentration in solution, resulting in surface saturation at high concentrations.

The experimental adsorption data were fitted according to the Langmuir isotherm model, the equation most usually used in the adsorption studies in solution, and the value obtained for the maximum adsorption capacity (q_m) was 1.03 mmol g^{-1}, equivalent to 385.1 mg of methylene blue dye per gram of adsorbent.

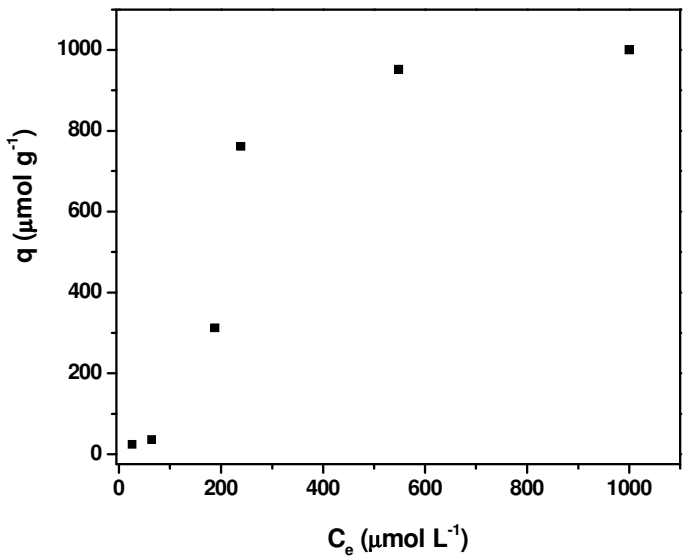

FIGURE 3 **Isotherm of methylene blue dye adsorption by pistachio shells.**

4 CONCLUSIONS

The kinetics results showed that the equilibrium was reached in about 90 minutes with a 74% reduction of the MB dye concentration by pistachio shells. Equilibrium adsorption studies showed that pistachio shells were efficient as an adsorbent for MB dye in aqueous solution. The Langmuir model provided a q_m value of 385.1 mg g^{-1}.

This result indicates a great adsorption capacity of MB dye by pistachio shells and suggests another possible use of this adsorbent material in removal of textile dyes from aqueous solutions.

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