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A Comparative Study on the Adsorption of Methylene Blue Using Rice and Coconut Husk

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ABSTRACT

Dyes are widely used for colouring in textile industries, and significant losses occur during the manufacture and processing of dyes, and these lost chemicals are discharged in the effluent. Methylene blue is one of the cationic dyes which are now used in textile industries. Adsorption of dyes is a new technology for treatment of wastewater containing different types of dyes. The goal of the present investigation is to develop a new and efficient adsorbent for methylene blue dye. Coconut and rice husk, a commonly available agriculture waste was investigated as viable materials for the treatment of methylene blue containing water. The results obtained from the experiments revealed the ability of rice and coconut husk in removing methylene blue and are dependent on the husk concentrations. This study shows that rice and coconut husk could be employed as low-cost and effective sorbent for the removal of methylene blue from aqueous solutions.

Keywords: Methylene blue, Rice husk, Coconut husk

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INTRODUCTION

The release of the colored dyes into the ecosystem is a dramatic source of aesthetic pollution, of eutrophication, and of perturbations in aquatic life. Some azo dyes and their degradation products such as aromatic amines are highly carcinogenic [1]. Proper treatment of the dye plant effluent is thus, a matter of concern before discharge. This led to an intensive search for the best available technology, which can be used for the removal and remediation of dyes. In addition, it makes the treatment of industrial effluent to be an important target for industry and environment protection. Different treatment methods are described in the literature, including filtration, flocculation, chemical precipitation, ion exchange, membrane separation, and adsorption [2]. Practically, dye removal process requires the following potential advantages for the adsorbent: (1) a large accessible pore volume, (2) hydrophobicity, (3) high thermal and hydrothermal stability, (4) no catalytic activity, and (5) easy regeneration. New approaches based on the use of natural, inexpensive sorbent materials for effluent treatment have been reported [3]. However, the use of these materials is still limited, although they show good adsorption capacity relative to that of the other expensive treatment processes [4]. The adsorption process is one of the efficient methods to remove contaminant from effluent [5]. The process of adsorption has an edge over the other methods due to its sludge free clean operation and complete removal of dye even from dilute solutions.

Rice husk, an undesirable agriculture mass residue in India, is a byproduct of the rice milling industry. It represents about 20% of the whole rice produced, on weight basis of the whole rice [6]. The estimated annual rice production of 500 million tons in developing countries, approximately 100 million tons of rice husks is available annually for utilization in these countries alone. Traditionally, rice husks have been used in manufacturing block employed in civil construction as panels and was used by the rice industry itself as a source of energy for boilers. However, the amounts of rice husk available are so far in excess of any local uses and have posed disposal problems. It was chosen because of its granular structure, chemical stability and its local availability at very low cost and there is no need to regenerate them due to their low production costs. The main constituents of rice husk are: 64-74% volatile matter and 12-16% fixed carbon and 15-20% ash [7]. The rice husk composition is: 32.24% cellulose, 21.34% hemicellulose, 21.44% lignin, 1.82% extractives, 8.11% water and 15.05% mineral ash [8]. The mineral ash is 94.5-96.34% SiO_2.

Coconut husk, a by product of coconut, is being used for the production of charcoal, fuel and brooms. The bulk of coconut husk is made up of cellulose and lignin (60%). The hydroxyl groups in these two polymeric substances provide sites for adsorption of dyes (Low and Lee., 1990). The purpose of this study is to investigate the adsorption capacity of coconut and rice husk on adsorption of cationic dye methylene blue from aqueous solution at laboratory scale.

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MATERIALS AND METHODS

Preparation of Sorbents

Rice husk was obtained from local rice mills and was washed several times with water followed by filtration, it was exposed to activation using citric acid [10] which was reported as follows: 100 g of rice husk were soaked in 0.6M citric acid for 2 h at 20°C. The acid-husk slurry was dried overnight at 50°C and the dried husk was then heated to 120°C. The reacted product was washed repeatedly with distilled water (200 ml per g of husk) to remove any excess of citric acid followed by oven drying overnight at 100°C.Coconut husks collected from coconut mill were dried at room temperature. After removing the outer layer, the husk was ground and then treated with a mixture of formalehyde/HCI according to the method of Randall (1978) for the treatment of peanut shell. It was then sieved in succession into various fractions after drying at 80°C. The largest fraction (55% by weight) of size 300-85011 was used in all the experiments. Methylene blue of 82% purity was used without further purification.

Preparation of Dye Solution

A stock solution of the dye was prepared by dissolving 1 gram of dye in 1000 ml distilled water to make a stock solution of 1000 mg/L. The experimental solution was prepared by diluting definite volume of the stock solution to get the desired concentration. For absorbance measurements a UV-VIS spectrophotometer was employed.

Adsorption Studies

Effect of time on the dye removal at various predetermined intervals was monitored by shaking the reaction mixture, centrifuged and analyzed for the dye content at the end of each contact time. Each flask represents an interval, i.e. one point on the curve. Time experiments were studied for different sorbent concentrations to study the effect of sorbent dosage on the adsorption of colour. Experiments were performed using sorbent concentrations of 2.5-10.0 g/l, in a dye solution of 10.0 mg/l for both coconut and rice husk.

The adsorption behaviours of the samples were studied by evaluating the percentage removal efficiency of methylene blue, from the relation

Removal efficiency = $[(C0 – C) ¸ C0] \times 100$

Where C0 is the initial concentration of methylene blue, C is the solution concentration after adsorption at any time.

RESULTS

The adsorption of methylene blue on rice husk and coconut husk were studied for its possible importance in the treatment of industrial effluents.

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Table 1. Influence of contact time and weight of rice husk on removal of Methylene blue(10 mg/l).

Type of adsorbent	Concentration of adsorbent (g/l)	Time (min)	% Removal
Rice husk	2.5	20	20
		40	22
		60	30
		80	30
		100	30
		120	30
	5.0	20	30
		40	42
		60	60
		80	60
		100	60
		120	60
	10	20	70
		40	72
		60	87
		80	87
		100	87
		120	87

The influence of time on removal of methylene blue was studied (Table 1&2). The adsorption of dye from solution increases with time and finally attains equilibrium. Equilibrium was attained at 80 min for rice husk at various concentrations. The amount of adsorbed dye increased with an increase in time and concentration ; remained nearly constant after equilibrium time. For a given mass of adsorbent, the amount of dye it can absorb is fixed. The higher the concentration of the dye, the smaller the volume it can remove. The rate of removal of colour was rapid initially. The rate levelled off gradually and then attained a more or less constant value beyond which there was no significant increase in colour removal. The removal curves are single, smooth and continuous leading to saturation. The dye colour removal pattern showed that an increase in the biomass concentration indicated increase dye removal capacity, which may be attributed to the increase of biomass of rice husk. An incremental increase was observed for increase of biomass from 2.5 to 5 g/l and from 5 to 10 g/l for rice husk

While for coconut husk, an incremental increase was observed for every 2.5 g/l increase of biomass. The effect of the amount of adsorbent on the adsorption of a fixed quantity of methylene blue is shown in Table 2. The rate of adsorption and the percentage removal of the dye increased with increasing the amount of husk. This is due to the increase in binding sites in the adsorbent, it can also follow from the above discussion that the coconut husk biomass uptake was dependent on coconut husk biomass. Equilibrium was attained at 60 min for coconut husk at various concentrations. Between the two husks taken for the present investigation, coconut husk exhibited greater percentage of methylene blue removal for all the three doses taken.

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Table 2. Influence of contact time and weight of coconut husk on removal of Methylene blue(10 mg/l)

Type of adsorbent	Concentration of adsorbent (g/l)	Time (min)	% Removal
Coconut husk	2.5	20	30
		40	45
		60	65
		80	65
		100	65
		120	65
	5.0	20	80
		40	85
		60	90
		80	90
		100	90
		120	90
	10	20	91
		40	92
		60	96
		80	96
		100	96
		120	96

DISCUSSION

The dye colour removal pattern showed that an increase in the biomass concentration indicated an increase in dye removal capacity, which may be attributed to the increase of biomass of husk which gives more surface area for sorption of the dye molecule on the surface [11]. The initial rapid adsorption of dye could be attributed to ion-exchange with surface cations on the husk followed by a gradual uptake which could be due to cation exchange at the inner surface [9]. Cocunut husk assumes importance than rice husk as the percentage removal of the dye is higher. This study shows that both rice and coconut husk could be employed as low-cost and effective sorbent for the removal of methylene blue from aqueous solution.

CONCLUSION

The results obtained from the present investigation revealed the ability of coconut and rice husk in treating methylene blue effluents. Adsorption is highly dependent on the contact time and adsorbent dose. The removal of methylene blue from was relatively higher for the coconut husk when compared to rice husk. Thus, these ecofriendly,natural and cheap biomass can be used in the removal of methylene blue from waste waters.

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REFERNECES

[1] Mohamed MM. J Colloid and Interface Science 2004; 272: 28-34.
[2] Tarley CRT and MAZ Arruda. Chemosphere 2003; 54: 987-995.
[3] Vaughan TC, W Seo and WE Marshall. Bioresource Technology 2001; 78: 133-139.
[4] Dushenkov V, PBAN Kumar, H Motto and I Raskin. Environmental Science and Technology 1995; 29: 1239-1245.
[5] Malik PK. Dyes and Pigments 2003; 56: 239-249.
[6] Daifullah AAM, BS Girgis, HMH Gad. Material letters 2003; 57: 1723-1731.
[7] Armesto L, A Bahillo, K Veijonen, A Cabanillas and J Otero. Biomass & Bioenergy 2002; 23: 171-179.
[8] Nakbanpote W, P Thiravetyan and C Kalambaheti. Minerals Engineering 2000; 13: 391-400.
[9] Low KS, Lee CK. Pertanika 1990; 13(2): 221-228.
[10] Marshall WE and LH Wartelle. Industrial Crops and Products 2003; 18: 177- 182.
[11] Mohan SM, NC Rao, KK Prasad and J Karthikeyan. Waste Management 2001; 22: 575-582.
[12] Randall JM, E Hantella, AG Walss. J Anal Polyrn Sci 1978; 22: 379-89.