Research Article

Ground Nut Shell and Spent Tea: An Eco-friendly Low Cost Adsorbent

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Accepted on: 06-01-2015; **Finalized on:** 28-02-2015.

ABSTRACT

As the current global trend towards more stringent environmental standards, technical applicability and cost-effectiveness became key factors in the selection of adsorbents for water and wastewater treatment. Recently, various low-cost adsorbents derived from agricultural waste, industrial by-products or natural materials, have been intensively investigated. In this study adsorption of methylene blue using various low cost adsorbent such as groundnut shell, and tea waste were used. Among this adsorbent tea waste showed 70% adsorption and groundnut shell showed 54% adsorption efficiency at constant time interval with variation in dye concentration. At constant dye concentration of 500mg/l, adsorbent dosage of 0.4 gm of ground nut shell showed highest adsorption efficiency of 94%. Also at constant dye concentration and adsorbent dosage and varying contact time, the tea waste has the efficiency of 86% dye removal which was higher than the ground nutshell.

Keywords: Adsorbent, Adsorbate, Adsorption, Groundnut shell, Tea waste, Natural adsorbent.

INTRODUCTION

Pollution is a major problem in the world due to increase of industrialization. Quality of water determines the quality of life. Quality of water is closely related to water use and to the state of economic development. Recent studies had dealt with effect of plant extract on domestic and industrial effluent[1-4] and also extracts of various seaweeds were analyzed for its effect on leather industry effluent.[5] Dyes are used extensively in sectors such as food, drug, cosmetics, textiles, ink, toner, press and auto motive industries for colorations. Methylene blue is a heterocyclic aromatic chemical compound with molecular formula $C_{16}H_{18}N_3SCl$.

Methylene blue is a cationic thiazine dye with the chemical name tetra methyl thionine chloride. It has a characteristic deep blue colour in the oxidized state. But the reduced form is leuko methylene blue (LMB) is colorless. Methylene blue has been used widely in variety of clinical settings to identify anatomic, pathologic and structure and to treat methemolobinesmia.

MB can cause eye burns, and if swallowed, it causes irritation to the gastrointestinal tract with symptoms of nausea, vomiting and diarrhea. It may also cause methemoglobinemia, cyanosis, convulsions and dyspnea if inhaled and anemia, nasal problems, serotonin syndrome, reticulosis, damage DNA.[6] Various physico–chemical and biological methods used for dye removal include chemical oxidation, reverse osmosis, ion exchange, ozonation, membrane filtration, coagulation, adsorption and microbial degradation.[7,8]

Adsorption is one of the most promising decolorization techniques in dyeing wastewater treatment. Adsorption techniques for wastewater treatment have become more popular in recent years owing to their efficiency in the removal of pollutants too stable for biological methods. Dye adsorption is a result of two mechanisms (adsorption and ion exchange) and is influenced by many factors as dye/adsorbent interaction, adsorbent's surface area, particle size, temperature, pH, and contact time.

The main advantage of adsorption recently became the use of low-cost materials, which reduces the procedure cost. Leaf powder of *Annona squamosa, Manilkara zapota, Prosopis julifora* and *Nymphae ampla* were also used as an adsorbent in reducing synthetic malachite green dyes.[9] Latest review focused on introducing the technology process, research history and research hotspot of adsorption.[10]

The use of different biosorbent as an alternative low cost adsorbent in the removal of methylene blue has been extensively studied.[11] Various techniques like precipitation, ion exchange, chemical, and adsorption have been used for the removal of toxic pollutant from, wastewater.

Methylene blue (MB) is selected as a model compound for evaluating the potential of tripoli to remove dye from wastewaters.[12] In this study, methylene blue was adsorbed using tea waste and groundnut shell.

MATERIALS AND METHODS

Preparation of Adsorbent

The groundnut shells were collected from fresh groundnut and the shells were washed with distilled water and then boiled at 100°C for 30 min. Then it was dried in a hot air oven at 80°C for 48 hours. Dried shells were crushed and passed through 25 mesh size and was stored.

The spent tea waste was collected from tea shop and it was washed with distilled water for 3-4 times to remove other contaminants. Tea waste was then boiled at 100°C

for 30 min and then dried in a hot air oven at 80°C for 48 hours. Seeds were crushed and passed through 25 mesh size sieve to get uniform particle size distribution of adsorbent. Then it was stored.

Figure 1: Groundnut shell powder

Figure 2: Spent Tea Waste powder

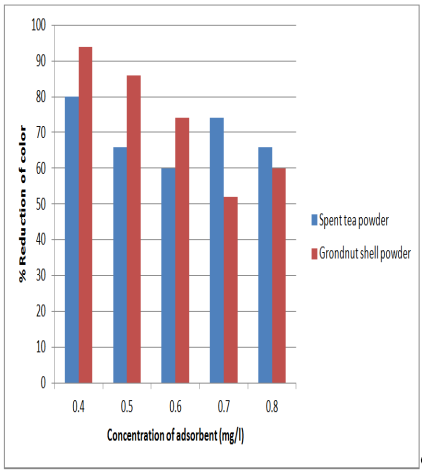

Figure 3: Effect of Adsorbent Dosage

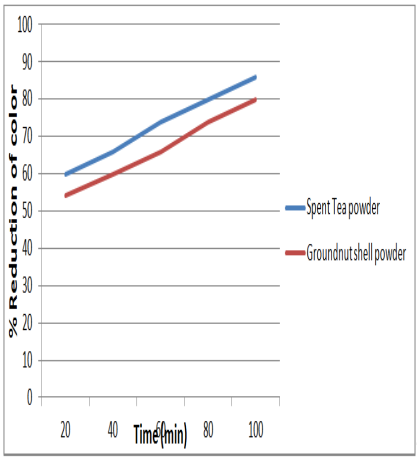

Figure 4: Effect of Time on Adsorption

Preparation of Adsorbate

A stock solution of methylene blue was prepared by dissolving 0.5 g of methylene blue dye in 1L of distilled water by constant stirring a magnetic stirrer at 400 rpm and 80°C for 1 hour for complete mixing. The solution is then cooled and filtered to get the clear stock solution and this is stored for further use.

Batch Adsorption Studies

The effect of initial dye concentration, adsorbent dose and contact time of agitation of adsorbate were studied using 100 mL of methylene blue dye solution in 250 mL standard conical flasks and required amount of adsorbents were added to each flask. Then the absorbance of the solution was found out using colorimeter.

$$\% \text{ Dye removal } = \frac{(C_o - C_f)/}{C_o} \times 100 \quad (1)$$

Where,

Co = Initial concentration of dye (mg/L)

C_f = Final concentration of dye (mg/L)

Effect of Initial Dye Concentration

Aliquots of methylene blue solution (100 mg/L – 500mg/L) were taken in 5 conical flasks and 0.5 g of adsorbent was added to each flask. It was kept in the shaker for 100 minutes.

After agitation the solutions were centrifuged at 7000 rpm for 15 minutes to remove colloidal materials. Then the absorbance of the supernatant solution was found out.

Effect of Adsorbent Concentration

Different amount of adsorbent such as 0.4, 0.5, 0.6, 0.7, 0.8 g was added to each flask containing constant dye concentration, then the mixture was agitated for 100 min then centrifuged.

After centrifugation, the OD of the treated dye was measured.

Effect of Time of Agitation

Dye and adsorbent concentration was kept constant and time was varied for treating the dye such as 20, 40, 60, 80 and 100 minutes. Then the OD was taken.

RESULTS AND DISCUSSION

Effect of Initial Dye Concentration

Table 1: Effect of initial dye concentration on adsorption with a constant adsorbent dose 0.5 g

S.No	Concentration of dye (mg/l)	% Reduction of color by Spent Tea powder	% Reduction of color by Groundnut shell powder
1.	100	70	30
2.	200	65	15
3.	300	33	33
4.	400	50	43
5.	500	66	54

Tea waste at 100mg/L showed max reduction of 70% adsorption and lower reduction was found to be 33% at 300mg/l. Ground nut shell showed max reduction at 500 mg/l (54%) and lower reduction at 200 mg/l (15%).

Effect of Adsorbent Dosage

In this, initial dye concentration was kept constant (500mg/l) and the dosage of adsorbent was varied. Tea waste showed gradual increase and decreases linearly from 80% to 63%. Groundnut shell showed max reduction of 93% to and lowest reduction of 50%.

Effect of Time of Agitation

Keeping the concentration constant how the time intervals were changed. The adsorption efficiency increased linearly for both the adsorbents. For Tea waste adsorption efficiency increased from 60% to 75%, and for Groundnut shell adsorption efficiency increased from 52% to 70%.

CONCLUSION

Adsorption is operative in most natural physical, biological, and chemical systems, and is widely used in industrial applications such as treatment of effluents, purification of water etc. In this study, low cost and easily available sources were chosen as adsorbent and its efficiency for various parameters also were analyzed. In future, the other parameters may also be optimized for getting better reduction in color.

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Source of Support: Nil, **Conflict of Interest:** None.