ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Biosorption of Malachite Green Dye Using Plant Leaf Powder

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ABSTRACT

Release of dyes into water bodies without treatment is a major threat to environment in developing countries. Dyes are coloring compounds which are used in textile industries abundantly and are released without treatment. In this study, fresh leaf powder of four plants such as *Annona squamosa, Manilkara zapota, Prosopis julifora*, and *Nymphae ampla* were used as an adsorbent in reducing synthetic malachite green dyes. Most of the color got reduced by *Nymphae ampla* which is abundantly present as a weed in all the fresh water bodies and *P.julifora* (88.75%) followed by *A.squamosa* (75%) and *M.zapota* (53.13%) at acidic pH 5.6.

Keywords: Malachite green, *Annona squamosa, Manilkara zapota, Prosopis julifora*, *Nymphae ampla*, adsorption.

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ISSN: 0975-8585

INTRODUCTION

Dyes have long been used in dyeing, paper and pulp, textiles, plastics, leather, cosmetics and food industries. Colors discharged from these industries posseses certain hazards and environmental problems. These colored compounds also inhibit sunlight penetration into the stream and affects aquatic ecosystem. Dyes usually have complex aromatic molecular structures which make them more stable and difficult to degrade. Furthermore, many dyes are toxic to some microorganisms and may cause direct destruction or inhibition of their catalytic capabilities.

The adsorption process is one of the effective methods for dye removal from the waste effluent. The process of adsorption has an edge over the other methods due to its sludge free clean operation and its capability of completely removing dyes, even from the diluted solution. Activated carbon (powdered or granular) is the most widely used adsorbents because it has excellent adsorption efficiency for the organic compound. Nevertheless, commercially available activated carbon is very expensive [1]. In 2005 Indra Deo Mall, Vimal Chandra Srivastava, Nitin Kumar Agarwal, Indra Mani Mishra studied the adsorptive removal of malachite green dye from aqueous solution by bagasse fly ash [2]. Numerous researchers worked earlier on variety of adsorbents: wool fiber and cotton fiber [3], banana pith [4, 5], biogas residual slurry [6], carbonized coir pith [7], neem (*Azadirachta indica*) husk [8], rice husk [9, 10], silk cotton hull, coconut tree sawdust [11], gypsum [12], tuberose sticks [13], tamarind fruit shell [14]. In this study fresh leaf powder of *Manilkara zapota, Annona squamosa, Prosopis julifora,* and *Nymphae ampla* were used as an adsorbent for the removal of synthetic malachite green dye removal.

MATERIALS AND METHODS

Preparation of Sorbent

The leaves of *Annona squamosa, Prosopis julifora* and *Manilkara zapota* and *Nymphae ampla* were collected from various places in Chennai, Tamil Nadu, India. The leaves were dried in hot air oven. Then the dried leaves were powdered using mixer and were used as a leaf powder adsorbent.

Preparation of Sorbate

An aqueous solution of malachite green with concentration of 80mg/l was prepared using distilled water and the pH was checked.

Treatment Process

An aliquot of 100ml of dye solution was treated for seven days with various amounts such as 2g, 1.5g, 1g and 0.5g of *Annona squamosa, Prosopis julifora, Manilkara zapota* and *Nymphae ampla* leaf powder which acted as an adsorbent. Different pH was maintained in the

treatment (5.6, 7.0 and 7.5). After the fifth day of treatment, the OD was taken using calorimeter at 680nm for all treated samples. Using standard graph the concentration of dye was calculated and the percentage removal of color was estimated using the following formula;

$$\% \text{ Removal} = ((C_o - C_f) / C_o)*100$$

C_o is the initial concentration of dye (g/l)
C_f is the final concentration of dye (g/l)

RESULTS AND DISCUSSION

Research in finding alternative methods for treating colored effluent is an emerging field in rural and urban areas of developing countries. In this study, various plant leaf powders in different amounts and varying pH were used as an adsorbent and their percentage removal of color was analyzed calorimetrically.

Effect of sorbent level is one of the important criteria in color reduction. All the plants showed maximum reduction at 1gm/100ml of sorbate. Among all the four plant *Nymphae ampla* reduced more color in all the dosage. *P.julifora* also showed higher reduction but only at 1gm/100ml of sorbate (88.75%), followed by *A.squamosa* (75%). *M.zapota* has adsorbed lesser color concentration (53.13%). Hence the optimum dosage of adsorbent was found to be 1gm of sorbent/100ml of sorbate. (Table.1 & 2).

Table.1 Details of sorbent

S.No	Plant	Collection area	Leaf powder adsorbent
1	*Manilkara zapota*	Madambakkam village	MZ
2	*Annona squamosa*	Madambakkam village	AS
3	*Prosopis julifora*	Madambakkam village	PJ
4	*Nymphae ampla*	Vengambakkam village	NA

Table.2 Effect of adsorbent dosage

S.No	Amount of adsorbent (gm)	Removal of color (%)			
		MZ	AS	PJ	NA
1	2.0	45.63	50	58.75	87.5
2	1.5	42.5	51.25	76.25	87.5
3	1.0	53.13	75.0	88.75	88.75
4	0.5	38.75	38.75	48.75	85.0

The pH of dye solution has significant effect on adsorption. More amount of dye was adsorbed at pH of 5.6. At this pH *N.ampla* and *P.julifora* has reduced 88.75% of dye, followed by *A.squamosa* (75%) and least reduction was found in *M.zapota* (53.13%). In neutral pH, higher color reduction was found in *N.ampla* (86.75%) and least was found in *M.zapota* (31.88%). At

pH 7.5, adsorption efficiency was reduced. *M.zapota* was not able reduce color more than 13.25% after 5th day. Hence the optimum pH was found to be 5.6. (Fig.1).

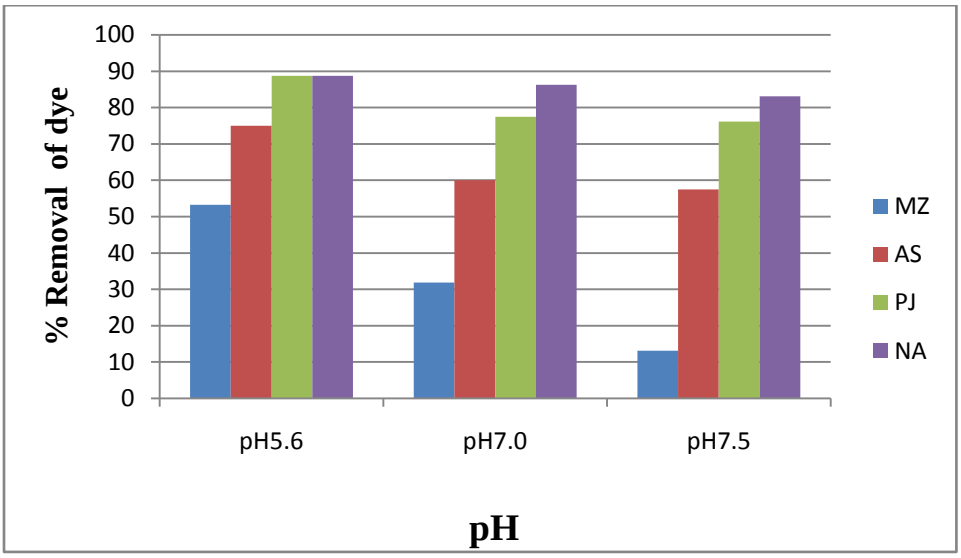

Figure 1: Effect of pH on adsorption (MZ – *Manilkara zapota;* AS –*Annona squamosa;* PJ-*Prosopis juliflora;* NA-*Nymphae ampla*)

CONCLUSION

Treatment of dye using fresh leaf powder is a simple and highly economic technology than all other technologies since it has very good potential of reducing color. Dyes which pollute large part of textile effluent can be transformed into colorless and non-toxic compounds by this technique. Thus, this method may be applicable for industrial purposes for improvement in quality of wastewater of textile industries and many others. Further more work for optimizing other parameters of colored effluent using this technology may be carried out to improve adsorption efficiency.

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