

Removal of Methylene Blue and Malachite Green by Agricultural Waste Material Stalks of *Cajanus cajan*

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The dyes like methylene blue and malachite green were removed by stalks of *Cajanus cajan*. Removal of dyes by agricultural waste was found to be comparable to the adsorbents like silica gel and graphite. The waste material was used for the removal of dyes without any chemical treatment. Sorption capacity of the stalks of *Cajanus cajan* for the removal of malachite green is more than for methylene blue. Sorption capacity was found to be nearly same at all the three temperatures (25, 30 and 40°C) indicating that this agricultural waste can be useful for the removal of dyes from the effluents in any season irrespective of temperature.

Key Words: Malachite green, Methylene blue, *Cajanus cajan*.

INTRODUCTION

Increasing water pollution is becoming a matter of great concern. Heavy metals, phenol and dyes etc. are present in industrial effluents as pollutants. The colour and dye bearing wastewater discharged into water streams not only contributes negatively to its aesthetic value but also offers considerable resistance to biodegradation and may upset aquatic life. Such coloured wastewaters are unfit for recycling without proper treatment. Dyes have been reported to have toxic effects¹⁻⁵. Activated carbon is the most commonly used adsorbent. However, due to its high cost and about 10-15% loss during regeneration, unconventional adsorbents like fly ash, peat, lignite, bagasse, pith, wood, sawdust etc. have attracted the attention of several investigators and their adsorption characteristics have been widely investigated for the removal of colour dyes, heavy metals, phenolic compounds and other refractory organics¹. Adsorption of dyes by insoluble salts and oxides has been studied during recent years mostly from the standpoint of the determination of adsorption isotherms and related quantities, e.g., particle size, surface area etc. The adsorption of dyes is fast and is completed within a short interval of time⁶⁻¹⁰. Newer low cost adsorbent materials like tree barks, cotton capsule shells, sawdust¹¹⁻¹⁷, rice straw, groundnut husk, carbon¹⁸, tea leaves¹⁹, waste wool²⁰, peanut skin²¹ etc. are being tried out for the removal of pollutants from waste water. The important criteria for the choice of the

adsorbing material include (i) volume and cost, and (ii) workability. Stalks of *Cajanus cajan* are available in abundance in Maharashtra. After harvesting, these stalks also pose a major problem of disposal. In the present study, the stalks of *Cajanus cajan* are used without any chemical treatment. In the present work we have studied the adsorption characteristics of a low cost agricultural waste, i.e., stalks of *Cajanus cajan*.

EXPERIMENTAL

Stalks of *Cajanus cajan* were collected from western Maharashtra. The material was shade dried and crushed. Solutions of methylene blue and malachite green of fixed concentration (3×10^{-5} M) were stirred with the crushed stalks of *Cajanus cajan*. The solution was filtered and its concentration was determined by measuring absorbance on a Systronics photoelectric colorimeter-112. The factors affecting the extent of removal such as time and temperature have been studied.

RESULTS AND DISCUSSION

Figs. 1 and 2 indicate that adsorption is fast during the initial stages and an appreciable fraction of the total uptake is completed within a short interval of time at high temperature (40°C). The amount of methylene blue removed is maximum at room temperature compared to high temperature and low temperature. The amount of malachite green removed is maximum at low temperature

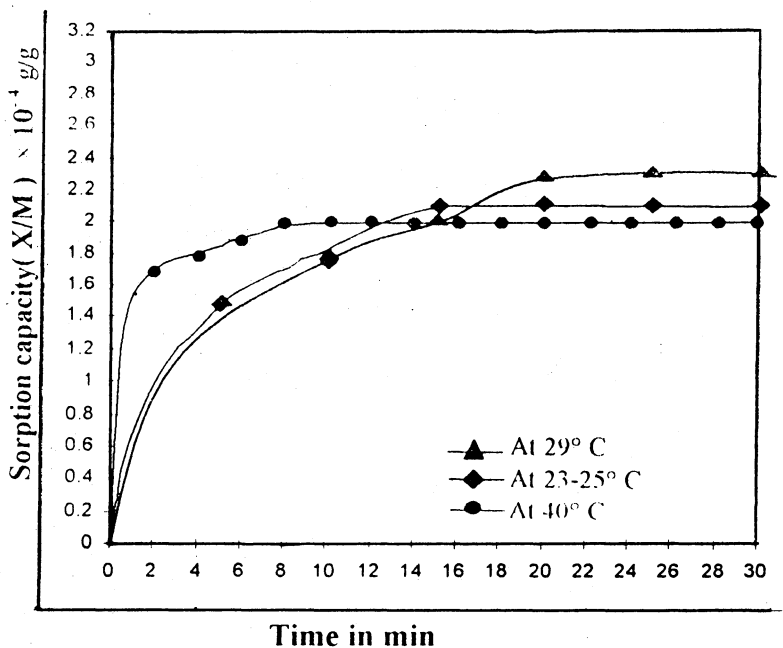


Fig. 1. Variation in removal of methylene blue with time at different temperatures

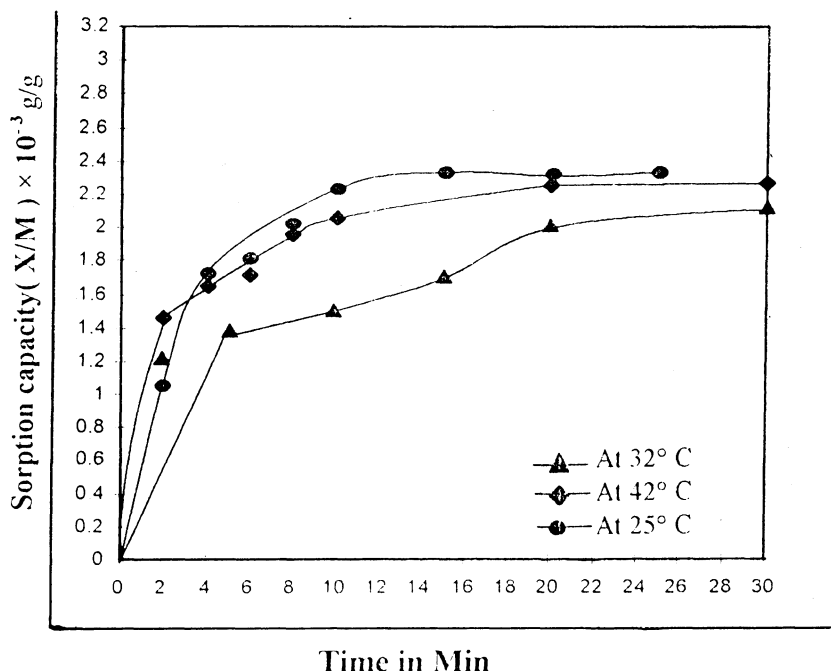


Fig. 2. Variation in removal of malachite green with time at different temperatures

compared to high temperature and room temperature. The time-variation curves are smooth and indicate a uniform process. Greater removal is shown by malachite green than by methylene blue.

In Maharashtra, there is varied range of temperature throughout the year. So it was thought necessary to carry out removal of dyes at three temperatures (25, 30 and 40°C). Sorption capacity was found to be nearly the same at all the three temperatures. Thus this agricultural waste can be used for the removal of dyes from the effluents in any season. Sorption capacity of the stalks of *Cajanus cajan* for the removal of malachite green is more than for methylene blue (Tables 1 and 2).

TABLE-1
EFFECT OF TEMPERATURE ON REMOVAL OF METHYLENE BLUE

Initial concentration (moles/L)	Temperature (°C)	Sorption capacity (g/g)
3×10^{-5}	25	2.1315×10^{-4}
3×10^{-5}	30	2.2976×10^{-4}
3×10^{-5}	40	2.0314×10^{-4}

The sorption capacity for malachite green by stalks of *Cajanus cajan* is 2.05126×10^{-3} (g/g adsorbent) at 30°C and 2.2549×10^{-3} (g/g adsorbent) at 42°C. Sorption capacity for methylene blue by stalks of *Cajanus cajan* is 2.2976×10^{-4} (g/g adsorbent) at 30°C and 2.0314×10^{-4} (g/g adsorbent) at 40°C. Sorption capacity for malachite green by graphite is 2.579×10^{-4} (g/g adsorbent)

at 35°C and 2.659×10^{-4} (g/g adsorbent) at 40°C⁶. Sorption capacity for methylene blue by graphite is 2.461×10^{-4} at 35°C and 2.596×10^{-4} at 40°C. In spite of the initial concentration taken in the same order, sorption capacity for malachite green by stalks of *Cajanus cajan* is more than by graphite (Table-3).

TABLE-2
EFFECT OF TEMPERATURE ON REMOVAL OF MALACHITE GREEN

Initial concentration (moles/L)	Temperature (°C)	Sorption capacity (g/g)
3×10^{-5}	25	2.3676×10^{-3}
3×10^{-5}	32	2.0512×10^{-3}
3×10^{-5}	42	2.2549×10^{-3}

TABLE-3
COMPARISON OF AMOUNT ABSORBED OF DYES ON STALKS OF CAJANUS CAJAN AND GRAPHITE

Adsorbate (initial concentration, M)	Temperature (°C)	Amount absorbed (g/g of stalks of <i>Cajanus cajan</i>)	Amount absorbed (g/g of graphite)
Methylene blue	35	2.2976×10^{-4}	2.461×10^{-4}
	40	2.0314×10^{-4}	2.596×10^{-4}
Malachite green	35	2.0512×10^{-3}	2.579×10^{-4}
	40	2.2549×10^{-3}	2.659×10^{-4}

Sorption capacity for malachite green is comparable to that as shown by silica gel (Table-4).

TABLE-4
COMPARISON OF AMOUNT ABSORBED OF DYES ON STALKS OF CAJANUS CAJAN AND SILICA GEL

Adsorbate (initial concentration, M)	Temperature (°C)	Amount absorbed (g/g of stalks of <i>Cajanus cajan</i>)	Amount absorbed (g/g of silica gel)
Methylene blue	35	2.2976×10^{-4}	3.114×10^{-4}
	40	2.0314×10^{-4}	3.053×10^{-4}
Malachite green	35	2.0512×10^{-3}	2.716×10^{-4}
	40	2.2549×10^{-3}	2.646×10^{-4}

Adsorption studies on different adsorbent materials like graphite and silica gel⁶ had shown comparable results to that as shown by stalks of *Cajanus cajan*. Silica gel and graphite are costlier adsorbents; so agricultural waste, stalks of *Cajanus cajan* used for the removal of dyes, may prove to be a better adsorbent material.

ACKNOWLEDGEMENTS

Authors' thanks are due to the Principal, S.P. College, Pune and to the Head, Department of Chemistry, S.P. College, Pune. One of us (MRD) is thankful to her colleagues for their cooperation.

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(Received: 26 March 2004; Accepted: 10 June 2004)

AJC-3455