Adsorption of Malachite Green with Chickoo peels, Yellow cucumber peels, Bitter gourd seeds and their activated carbon

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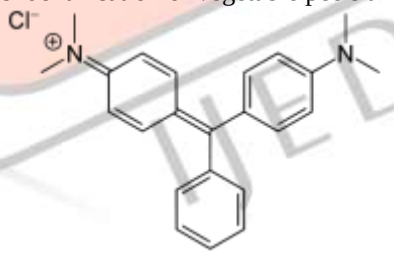
Abstract: Malachite Green is a synthetic dye. It is a water pollutant from various industries. It contaminates the water resources and thus harms the environment. This study involves the removal of malachite green dye from its aqueous solution by using yellow cucumber (cucumis sativus) peels, Chickoo (Manilkara zapota) peels and bitter gourd (Momordica charantia)seeds are as well as by using activated carbon derived from these peels and seeds and these are found to be effective biosorbents. Malachite Green aqueous solution is used in different concentrations. The effect of pH and amount of adsorbent dosage is also studied. The Freundlich and Langmuir adsorption isotherms have been verified by the experimental data.

Keywords: Malachite Green, Adsorption, Adsorption isotherms, Biosorbents , Vegetable peels and seeds

I. INTRODUCTION

Synthetic dyes are serious threat to the environment[1].Dyes are mostly used in textile industries as well as in pharmaceutical, food, cosmetics, plastics, photographic and paper industries[2] . Central pollution control board has listed the dyeing industry as one of the heavily polluting industries[3] These dye effluents can be removed from water by physical, chemical and biological methods[4] . Physical methods includes adsorption, ion exchange, and filtration/coagulation methods etc. while chemical methods includes ozonisation, Fenton reagent, photo catalytic reactions and biological methods include aerobic degradation, anaerobic degradation, biosorption[5] etc. Adsorption found to be very effective and cheap method among the all available dye removal methods[5] .The dye contaminated water can also be treated by by nanofiltration[6] or by Electrocoagulation[7] which is an electrochemical technique. Malachite Green is cationic synthetic dye acutely toxic to a wide range of aquatic and terrestrial animals[8] .It is associated with cytotoxic, genotoxic and carcinogenic potential[9] .Use of biowaste[10,11,12,13,14,15] as dye adsorbent is an ecofriendly practice. This study includes identification of vegetable peels and seeds as adsorbents of Malachite Green.



II. MATERIALS AND METHODS

Adsorbate Preparation

$1x10^{-5}$ M aqueous solution of Malachite Green is prepared as stock solution .This stock solution is made into various dilutions and then used for adsorption studies.

Adsorbent Preparation

The vegetable and fruits waste like yellow cucumber *peels, Chickoo peels and bitter gourd seeds* are collected, washed , dried, finely powdered and sieved for uniformity and stored in separate air tight containers and the activated carbon of these vegetable and fruits waste - *yellow cucumber peels, Chickoo peels and bitter gourd seeds is also prepared by heating each of them separately at* 300^0C *in a muffle furnace.*

III. EXPERIMENT

In this study different dilutions of malachite green were prepared using its stock solution for testing the adsorption characteristics of adsorbents. The amount of adsorbent used was 0.1gms/50ml of adsorbate. A Constant time of 60 min. was maintained for every adsorption and the adsorbate is filtered and filtrate is collected and its optical density values were determined to check the discoloration. Chemicals used in this study were of analytical grade.

IV. RESULT AND DISCUSSION

The adsorption properties of the *yellow cucumber peels, Chickoo peels and bitter gourd seeds* have been studied by using

Freundlich and Langmuir adsorption isotherms . Langmuir adsorption isotherms equation is valid for monolayered sorption onto a surface with a finite number of identical sites.

Langmuir adsorption isotherms equation is Ce/x/m = ab* Ce/1+ab where a and b are Langmuir constants.

Freundlich adsorption isotherms equation is ln x/m = ln k + 1/n *lnCe

Table 1 Adsorption constants for Malachite green with following peels and seeds Langmuir isotherm parameters

Adsorbent	a	b	KL
Bitter gourd seeds	285714.2	$1.4x10^{-6}$	0.4
Chickoo peels	99999.9	$1.0x10^{-5}$	1
Yellow cucumber peels	48309.17	$3.46x10^{-6}$	0.16

Table 2 Adsorption constants for Malachite green with following peels and seeds Freundlich isotherm parameters

Adsorbent	k	n
Bitter gourd seeds	3.981×10^{-2}	1.0
Chickoo peels	7.943×10^{-1}	0.76
Yellow cucumber peels	1.258×10^{-1}	0.83

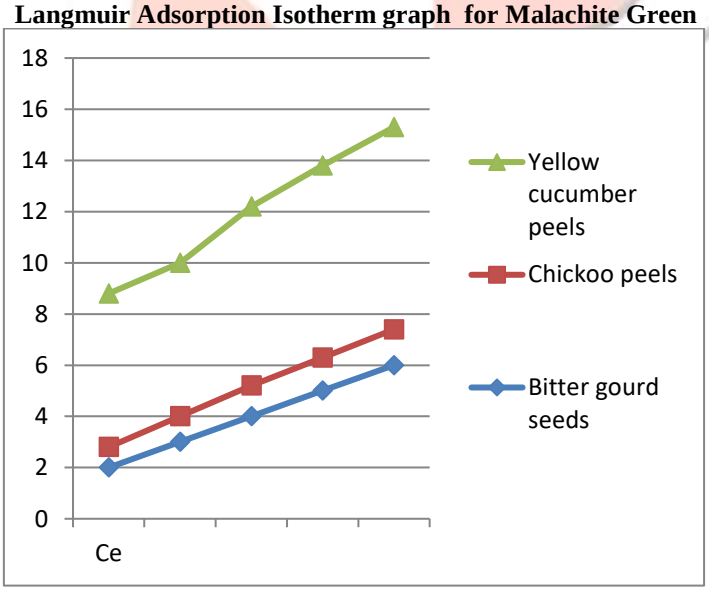
Table 3 Adsorption constants for Malachite green with activated carbon extracted from following peels and seeds Langmuir isotherm parameters

Adsorbent	a	b	KL	
Bitter gourd seeds activated carbon	123152.7	1.31×10^{-5}	1.6	
Chickoo peels activated carbon	178571.4	1.6×10^{-5}	2.85	
Yellow cucumber peels activated carbon	374531.8	3.8×10^{-6}	1.4	

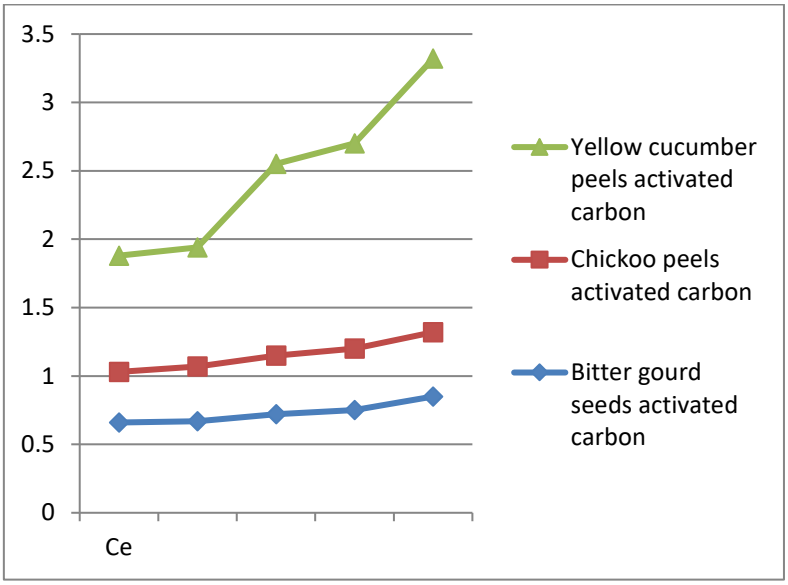
Table 4 Adsorption constants for Malachite green with activated carbon extracted from following peels and seeds Freundlich isotherm parameters

Adsorbent	k	n
Bitter gourd seeds activated carbon	1.258×10^{-1}	1.1
Chickoo peels activated carbon	1.995×10^{-1}	1.1
Yellow cucumber peels activated carbon	1.584×10^{-2}	1.8

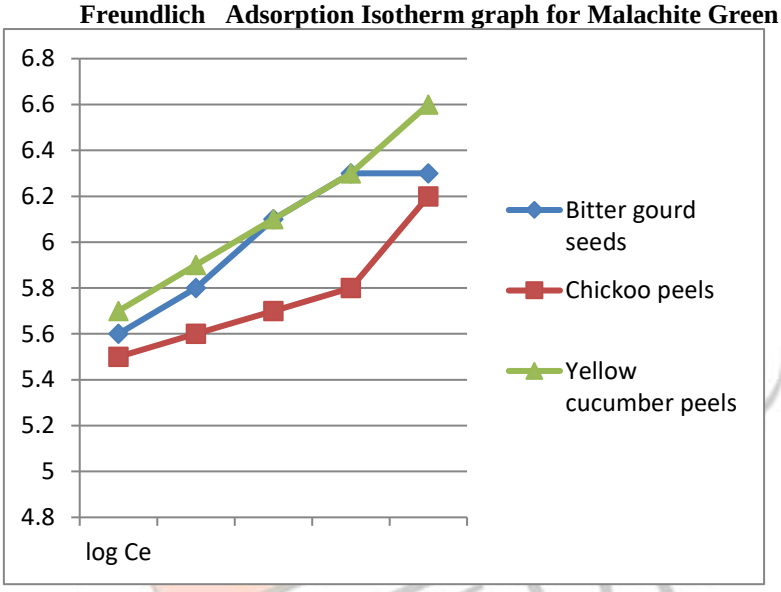
Langmuir Adsorption Isotherm graph for Malachite Green



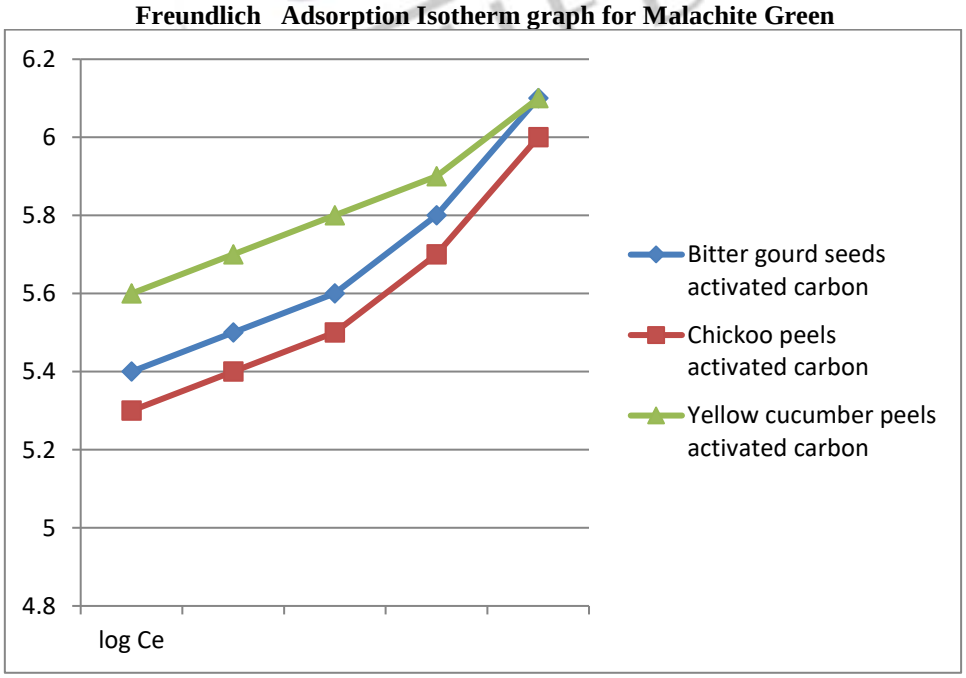
Langmuir Adsorption Isotherm graph for Malachite Green



Freundlich Adsorption Isotherm graph for Malachite Green



Freundlich Adsorption Isotherm graph for Malachite Green



Percentage removal of dye is calculated as follows

$$\% \text{ removal} = (C_o - C_e) \times 100/C_o$$

Where C_o is the initial concentration of dye that is before adsorption and C_e is the final concentration of dye that is after adsorption

Adsorbent	% removal of malachite green
Bitter gourd seeds	40
Chickoo peels	60
Yellow cucumber peels	33

Adsorbent	% removal of malachite green
Bitter gourd seeds activated carbon	70
Chickoo peels activated carbon	81
Yellow cucumber peels activated carbon	50

V. CONCLUSION

The results obtained for the study of adsorption properties of *yellow cucumber peels, Chickoo peels and bitter gourd seeds* are in agreement with Langmuir and Frendlich adsorption isotherms. The maximum value of kL from Langmuir adsorption isotherms suggests the chickoo peels having maximum adsorption potential for malachite green dye. The activated carbon derived from these biosorbents are found to be more efficient adsorbent than their original forms . Maximum adsorbtion is found at Ph 5-6. With increase in the amount of adsorbent dosage adsorption also increases.

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