iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XI **Month of publication:** November 2017

DOI:

Effects of Waste Pisum Sativum Pod Adsorbent Size and Dose on Efficiency of Decolourization of Synthetic Dyes

SudeviBasu[1], Juhi[2], Kavya H[3], Rajlaxmi Dash[4], Sumi[5]
[1, 2, 3, 4, 5] *Department of Biotechnology, Sir M Visvesvaraya Institute of Technology*

Abstract: The synthetic dyes from industrial discharges cause water pollution when directly discharged into water bodies due to their bright colour, complex structure, persistence nature and adsorption is found to be a simple and cost effective method for decolourizing synthetic dyes. This research is carried out to investigate the effect of adsorbent size and dose of eco-friendly, cost effective adsorbent from waste Pisumsativum pods on the decolourization efficiency of synthetic dyes (Crystal Violet, Methylene Blue and Malachite Green).For MG dye, Pisumsativum pod adsorbent size of 0.246 mm is good for its removal whereas for CV and MB dyes, the adsorbent size of 0.604 mm is better. Further the adsorbent dose of 0.5 gm is suitable to remove colour of CV dyes and 1 gm is needed to decolourize MG and MB dyes to a good extent. Also this research has revealed that adsorption capacity decreases with increasing adsorbent dose for all the three dyes.
Keywords: Synthetic Dyes, Water Pollution, Decolourization, Adsorption, Adsorbent, Pisumsativum

I. INTRODUCTION

Colour of dyes from industries like textiles, rubber, paper and pulp industries is a major problem when discharged in natural water bodies. The dyes are difficult to degrade due to their complex aromatic structures, persist in the environment, pollute the water bodies and affect aquatic life and enter into food webs and have carcinogenic and mutagenic effects (Vinothet al., 2010; Abbas et al., 2011; Karthik et al., 2012). Amongst different treatment techniques explored, adsorption is an efficient, effective and best equilibrium process for the removal of colour of synthetic dyes in wastewater (Sharmaand Bhattacharya,2005;Karthiket al., 2012).Natural adsorbent Pisumsativumpodis found effective in decolourizing synthetic dyes (Basuet al., 2017). This research describes the effects of adsorbent size and dose on the efficiency of decolourizing three synthetic dyes (Crystal Violet, Methylene Blue and Malachite Green) since the size and dose are significant parameters to study the efficiency of adsorption.

II. MATERIALS AND METHODOLOGY

A. Preparation of Adsorbent

Waste *Pisumsativum* pods are collected from home and washed with distilled water and allowed to dry under the sun till these have become crisp and easy to crush. These are then powdered in mixer and are passed through sieves of 0.246 mm and 0.604 mm to obtain uniform particle size of adsorbents. The size of the sieve was chosen according to the study by Abdul Karim*et al.*, 2015 and higher sieve size is chosen to study the effect of adsorbent size on efficiency of adsorption. The adsorbents are stored in air tight containers.

B. Preparation of Adsorbate

A stock solution of 0.5 g/L of three different dyes (Crystal Violet (CV), Methylene Blue (MB) and Malachite Green (MG)) are prepared separately and stored in different volumetric flasks. Optical Density is taken at the respective nanometres for the dyes using Systronics Photoelectric Colorimeter 114 and the pH is measured using Digital pH meter MK VI as shown in Table 1.

Table 1 List of Dyes with pH and OD

Sl. No	Types of Dyes	pH	OD for the dyes (nm)
1.	Malachite Green	3.09	590
2.	Crystal Violet	3.43	650
3.	Methylene Blue	6.76	650

C. *Batch Studies*

Aliquots of the single dyes are prepared to obtain solutions with concentrations 12.5 – 62.5 mg/L and the volume is made to 100 mL.

1) *Effect of Adsorbent Size:* The dyes are taken in 250 mL conical flasks and 0.5 g of Pisumsativum pod adsorbent of 0.246 mm is weighed and added to each conical flask. The size of the sieve was chosen according to the study by Abdul Karimet al., 2015. This is repeated for all three dyes. Similarly 0.5 g of Pisumsativum pod adsorbent of 0.604 mm size is added to the conical flasks and is repeated for all three dyes. The solutions are agitated at a constant room temperature of 33 ^{0}C and speed of 240 wrist action per minute using Secor India Griffin Flask Shaker for 60 minutes. The adsorb ate is filtered out using ordinary filter paper from each of the conical flasks in order to get a clear solution. The optical density is measured at respective OD shown in Table 1.
2) Effect of Adsorbent Dose: The dyes are taken in 250 mL conical flasks and 0.5 g of Pisumsativum pod adsorbent of 0.246 mm is weighed and added to each conical flask. This is repeated for all three dyes with adsorbent dose of 1 g. Similar procedure is followed with adsorbent size of 0.604 mm with adsorbent dose of 0.5 g and 1 g. The solutions are agitated at a constant room temperature of 33^{0}C and speed of 240 wrist action per minute using Secor India Griffin Flask Shaker for 60 minutes. The adsorb ate is filtered out using ordinary filter paper from each of the conical flasks in order to get a clear solution. The optical density is measured at respective OD shown in Table 1.

The percentage removal of adsorb ate adsorbed on the adsorbent is calculated as

$$\% Dye\,\mathrm{Re}\,moval = \frac{(C_0 - C_f)}{C_0} * 100 \text{--(1)}$$

Where C_0 = Initial Concentration of Dye (mg/L)

C_f = Final Concentration of Dye after Adsorption (mg/L)

The amount of adsorbate adsorbed per unit weight of adsorbent is given as

$$Q = \frac{(C_0 - C_f)}{W} * V \text{ (mg/g)--(2)}$$

Where V = Volume of Solution (L)

W = Weight of Adsorbent (g)

III. RESULTS AND DISCUSSIONS

A. *Effect of Adsorbent Size*

With initial concentration of 12.5 mg/L, at constant adsorbent dose of 0.5 g and contact time of 1 h, with two different sizes of adsorbent, 0.246 mm and 0.604 mm, the percentage dye removal of MG is 86.96% and 84.78% respectively whereas with final concentration of 62.5mg/L, the percentage dye removal is found to be 42.86% and 29.76% (Figure 1). Also at 1 g of adsorbent dose and contact time of 1 h with two different sizes of adsorbent, 0.246 mm and 0.604 mm, at initial concentration of 12.5mg/L, the percentage dye removal is found to be 89.13% and 86.96% and with final concentration of 62.5mg/L, the percentage dye removal is found to be 51.19% and 52.38% (Figure 2). For MG, it can be observed that as the adsorbent size increases, the percentage dye removal decreases. This is because smaller particles have large surface area than larger particles and hence adsorb more dye during initial stages of adsorption and gradually decreases due to decrease in available surface area. For larger particles, the diffusion resistance to mass transfer is high and most of the internal surface of the particle may not be utilized for adsorption and so the amount of dye adsorbed is small (Sharma *et al*., 2016). Further, Figure 1 shows that with initial concentration of 12.5mg/L, at two different sizes of adsorbent namely 0.246 mm and 0.604 mm keeping constant adsorbent dose of 0.5 gm and contact time of 1 h, the percentage dye removal of MB is found to be 76.47% and 78.43% respectively whereas with final concentration of 62.5mg/L, the percentage dye removal is found to be 47.06% and slightly less at 38.82% respectively. Also at 1 gm of adsorbent dose (Figure 2), with initial concentration of 12.5mg/L, the percentage dye removal for different sizes were found to be 80.39% and 82.35% and with final concentration of 62.5mg/L, the percentage dye removal is found to be 37.65% and 49.41%. Similar trend is observed for CV dye. With initial concentration of 12.5mg/L, at adsorbent sizes of 0.246mm and 0.604mm keeping constant adsorbent dose of 0.5g and contact time of 1 h, the percentage dye removal of CV (Figure 1) is found to be same at 37.5% whereas with final

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

concentration of 62.5mg/L, the percentage dye removal is 61.91% and 66.67% respectively. Also at constant adsorbent dose of 1 gmand contact time of 1 h, with initial concentration of 12.5mg/L, the percentage dye removal at adsorbent sizes of 0.246 mm and 0.604 mm is 25% and 12.5% and with final concentration of 62.5mg/l, the percentage dye removal is found to be 47.62% and 52.38% respectively (Figure 2). This is because as the particle size increases, the number of micro pores also increases. The increase in micro pores increases the number of accessible sites, hence increases the percentage adsorption. This is similar to the work by Charles and Odoemelam, 2010. For CV dye, the increase in percentage dye removal at final concentration is because the adsorbed dye molecules tend to increase adsorption of other molecules. Also the dye molecules have to encounter the boundary layer effect before diffusing from boundary layer film onto adsorbent surface and then its diffusion into porous structure of adsorbent. This is similar to the work done by (Basu*et al.*, 2013).

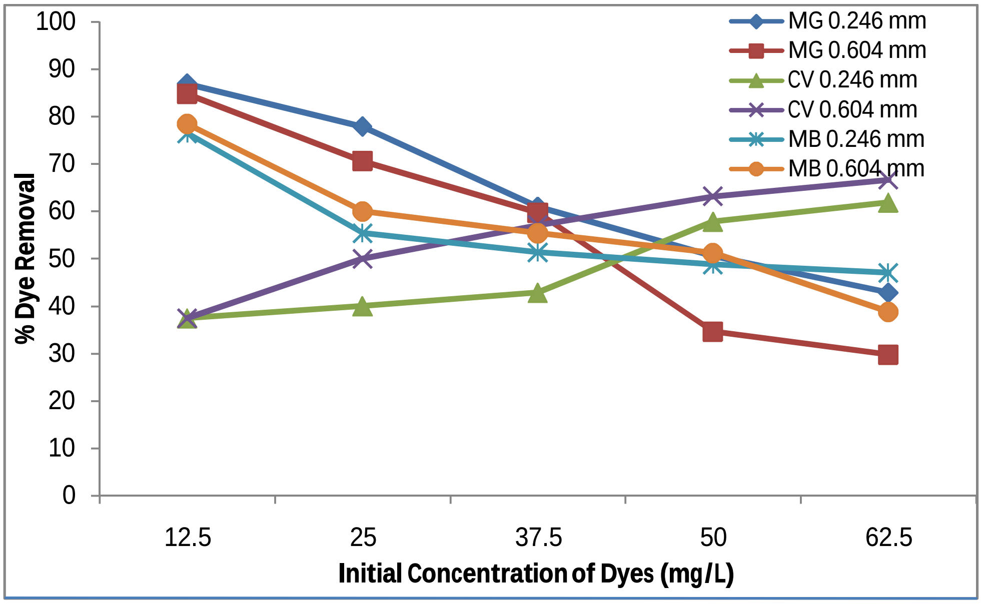


Figure 1: Effect of Adsorbent Size on Percentage Dye Removal with Adsorbent Dose of 0.5 gm

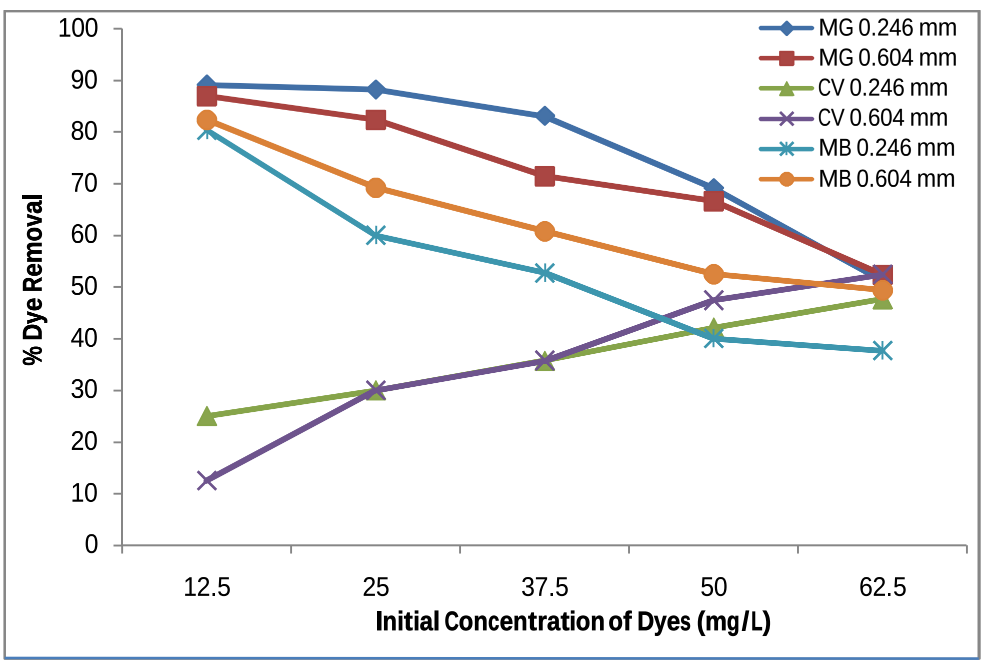


Figure 2: Effect of Adsorbent Size on Percentage Dye Removal with Adsorbent Dose of 1 gm

B. Effect of Adsorption Dose

From Figure 3, for MG dye, keeping particle size at 0.246 mm and contact time of 1 h constant, at initial concentration of 12.5mg/L, the percentage dye removal with adsorbent dose of 0.5gm and 1gmare 86.96% and 89.13% respectively. At final concentration of 62.5 mg/L, keeping other parameters constant, the percentage dye removal with adsorbent dose of 0.5gm and 1gmare 42.86% and 51.19% respectively. Similarly, keeping particle size at 0.604 mm constant, at initial concentration of 12.5mg/L, the percentage dye removal for adsorbent dose of 0.5gm and 1gmare 84.78% and 86.95%.At final concentration of 62.5 mg/L, the percentage dye removal at adsorbent dose of 0.5gm and 1gmare 29.76% and 52.38% (Figure 4). For MB dye, keeping particle size of 0.246 mm and contact time of 1 h constant (Figure 3), at initial concentration of 12.5mg/L, the percentage dye removal for MB dye at adsorbent dose of 0.5 gm and 1 gm are 76.47% and 80.39%respectively. At final concentration of 62.5 mg/L, the percentage dye removal for adsorbent dose of 0.5gm and 1gmare 47.06% and 37.65%. Similarly, keeping particle size of 0.604mm constant(Figure 4), at initial concentration of 12.5mg/L, the percentage dye removal for MB dye at adsorbent dose of 0.5gm and 1gmare 78.43% and 82.35% respectively while at final concentration of 62.5 mg/L, the percentage dye removal for adsorbent dose of 0.5gm and 1gmare 38.82% and 49.41% respectively. Itis observed that percentage of dye removal increases with increase in adsorbent dose. The reason is attributed to the fact that increase in the adsorptive surface area leads to availability of more active adsorption sites and hence adsorption efficiency also increases and is similar to the work done by Raghuvanshiet al., 2008; Baskeret al., 2014 and Ladhe and Patil, 2014.However, a reverse trend is observed for CV dyes wherein the percentage dye removal increased with lower adsorbent dose both at 0.246 mm and 0.604 mm of adsorbent size (Figure 3 and 4). Keeping particle size of 0.246 mm and contact time of 1 h constant, at initial concentration of 12.5mg/L, the percentage dye removal for adsorbent dose of 0.5gm and 1gmare 37.5% and 25% respectively whereas at final concentration of 62.5 mg/L,the percentage dye removal with adsorbent dose of 0.5gm and 1gmare 61.90% and 47.62% respectively (Figure 3). Similarly, keeping particle size of 0.604 mm and contact time of 1 h constant (Figure 4), at initial concentration of 12.5mg/L, the percentage dye removal with adsorbent dose of 0.5 gm and 1 gmare 37.5% and 12.5% respectively. Similarly at final concentration of 62.5mg/L, the percentage dye removal with adsorbent dose of 0.5gm and 1gmare 66.67 % and 52.38% respectively. Unit adsorption decreases with increase in adsorbent dose. This may be attributed to overlapping or aggregation of adsorption sites resulting in decrease in total adsorbent surface area available and an increase in diffusion path length (Raoet al., 2011). According to Teka and Enyew, 2014, the decrease in percentage adsorption with increase in dose could be due to the clash and closure of active sites.

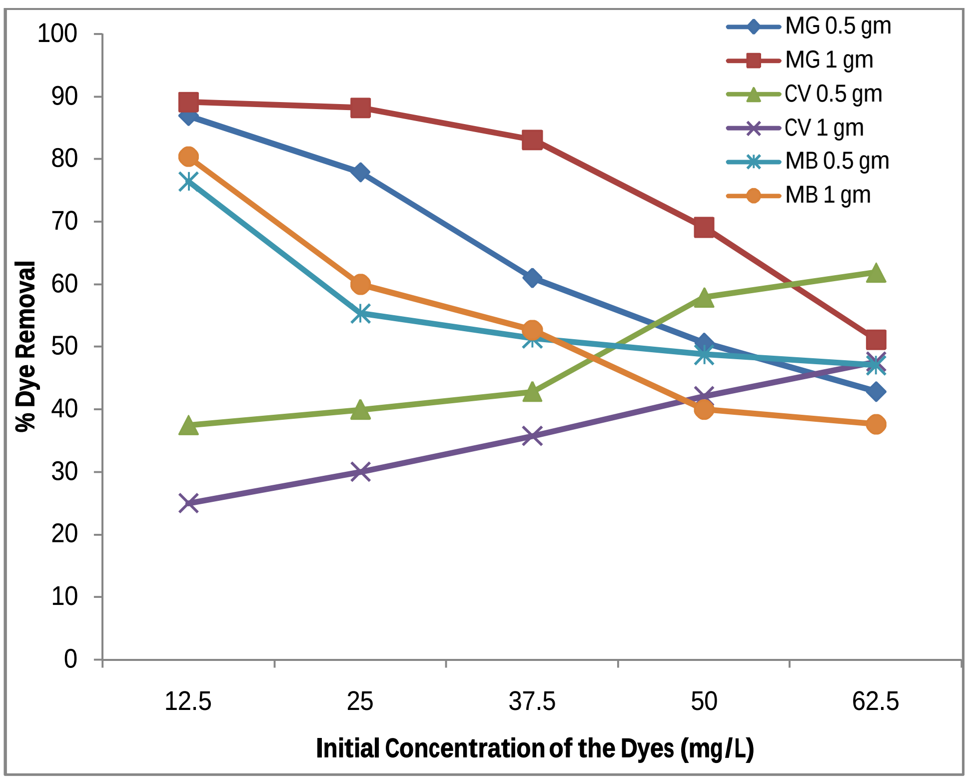


Figure 3: Effect of Adsorbent Dose on Percentage Dye Removal with Adsorbent Size of 0.246 mm

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

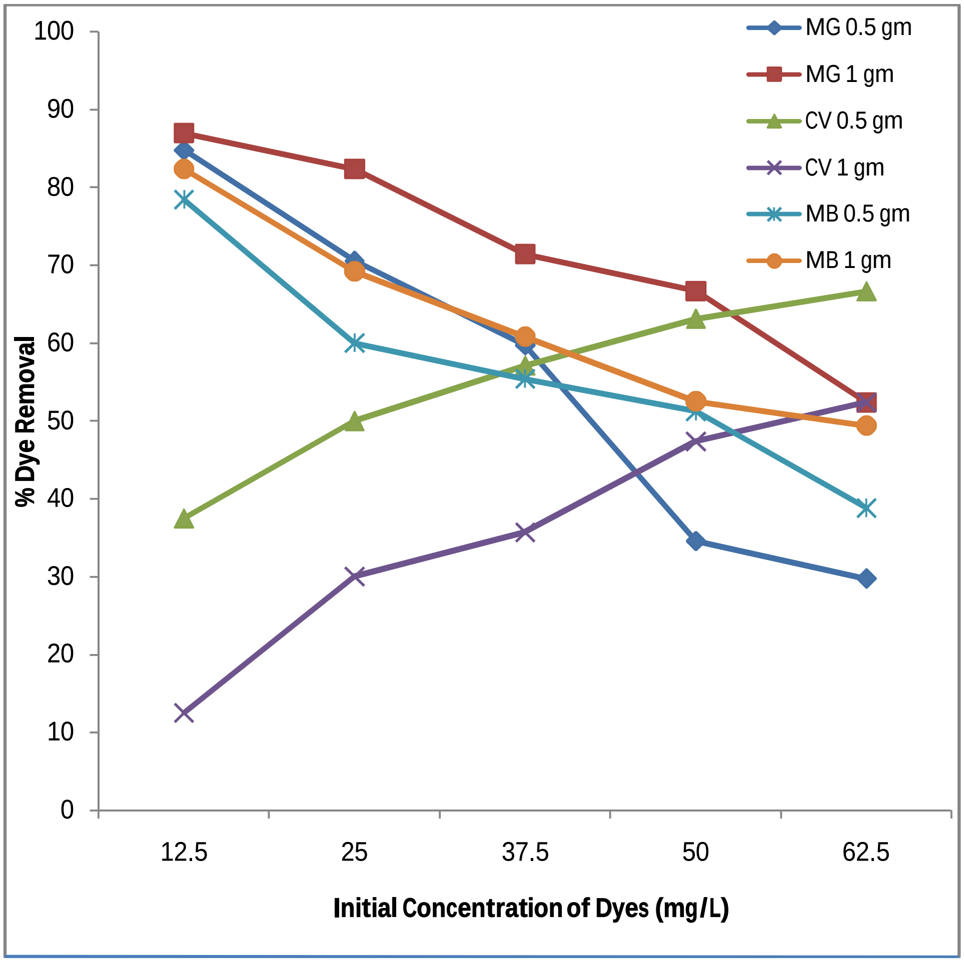


Figure 4: Effect of Adsorbent Dose on Percentage Dye Removal with Adsorbent Size of 0.604 mm

Figures 5 and 6 show the effect of adsorbent dose on adsorption capacity or amount of dye adsorbed with adsorbent sizes of 0.246 mm and 0.604 mm respectively. As seen in Figure 5, with adsorbent size of 0.246 mm and adsorbent dose of 0.5 gm, at initial concentration of 12.5 mg/L, the amount of dye adsorbed for MG, MB and CV dyes are2.17 mg/g, 1.91 mg/g and 0.94 mg/g respectively whereas with adsorbent size of 0.246 mm and dose of 1 gm, at initial concentration of 12.5 mg/L, the amount of dye adsorbed for MG, MB and CV dyes decreased to 1.11 mg/g, 1.0 mg/g and 0.31 mg/g respectively. Similar trend is observed at final dye concentration of 62.5 mg/L, with adsorbent size of 0.246 mm, and dose of 0.5 gm(Figure 5), the amount of dye adsorbed for MG, MB and CV dyes are 5.36 mg/g, 5.88 mg/g and 7.74 mg/g respectively whereas with adsorbent size of 0.246 mm and dose of 1 gm, at final dye concentration of 62.5 mg/L, the amount of dye adsorbed for MG, MB and CV dyes decreases to 3.19 mg/g, 2.35 mg/g and 2.98 mg/g respectively. The same trend is observed at adsorbent size of 0.604 mm (Figure 6). From Figure 6, with adsorbent size of 0.604 mm and adsorbent dose of 0.5 gm, at initial concentration of 12.5 mg/L, the amount of dye adsorbed for MG, MB and CV dyes are 2.12 mg/g, 1.96 mg/g and 0.94 mg/g respectively whereas with adsorbent size of 0.604 mm and dose of 1 gm, at initial concentration of 12.5 mg/L, the amount of dye adsorbed for MG, MB and CV dyes decreases to 1.09 mg/g, 1.03 mg/g and 0.16 mg/g respectively. Similar trend is observed at final dye concentration of 62.5 mg/L, with adsorbent size of 0.604 mm, and dose of 0.5 gm (Figure 6), the amount of dye adsorbed for MG, MB and CV dyes are 3.72 mg/g, 4.85 mg/g and 8.33 mg/g respectively whereas with adsorbent size of 0.604 mm and dose of 1 gm, at final dye concentration of 62.5 mg/L, the amount of dye adsorbed for MG, MB and CV dyes decreases to 3.27 mg/g, 3.09 mg/g and 3.27 mg/g respectively. This may be due to overlapping of adsorption sites, overcrowding of adsorbent particles and screening effect of dense outer layer of cells, thus shielding the binding sites from the dye solution. This work is similar to the research by Tuminet al., 2008 and Fatiha and Belkacem, 2016.

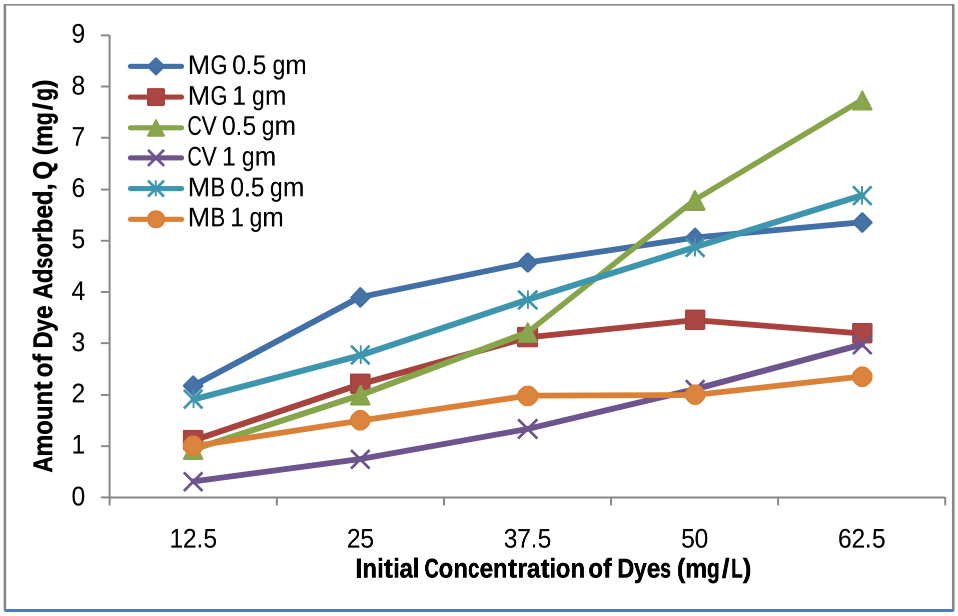


Figure 5: Effect of Adsorbent Dose on Amount of Dye Adsorbed with Adsorbent Size of 0.246 mm

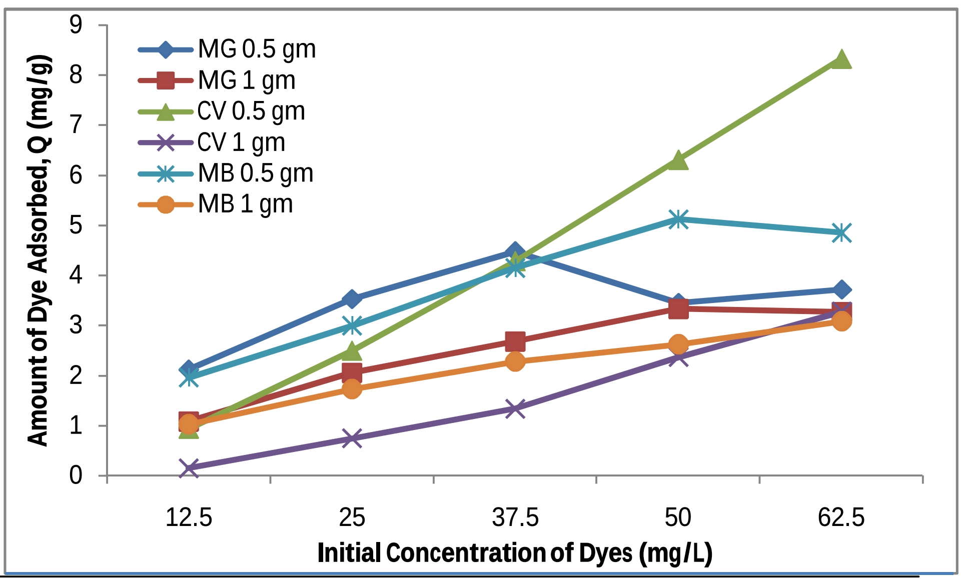


Figure 6: Effect of Adsorbent Dose on Amount of Dye Adsorbed with Adsorbent Size of 0.604 mm

IV. CONCLUSIONS

From this research it is seen that Pisumsativum pod adsorbent size and dose determines its efficiency. For MG dye, as the adsorbent size increases, the percentage dye removal decreases where as for CV and MB dyes, as the particle size increases, the percentage adsorption also increases. Hence for MG dye, Pisumsativum pod adsorbent size of 0.246 mm is good for its removal whereas for CV and MB dyes, the adsorbent size of 0.604 mm is better. Further the percentage of dye removal increases with increase in adsorbent dose for MG and MB dyes while adsorption decreases with increase in adsorbent dose for CV dyes. So it is concluded that adsorbent dose of 0.5 gm is suitable to remove colour of CV dyes and 1 gm is needed to decolourize MG and MB dyes to a certain extent. Also adsorption capacity decreases with increasing adsorbent dose for all the three dyes.

V. ACKNOWLEDGEMENT

The authors acknowledge the resources and facilities provided by the Department of Biotechnology, Sir M. Visvesvaraya Institute of Technology, Bengaluru, for carrying out this research work.

REFERENCES

[1] Abbas A., Murtaza S. and Munir M., (2011), “Removal of Congo Red from Aqueous Solutions with RaphanussativusPeels and Activated Carbon: A Comparative Study”, American-Eurasian Journal of Agricultural and Environmental Science, Vol. 10, No. 5, pp 802-809.

[2] Abdul Karim S. K., Rabuyah Ni., Asli M A. and Ismail S H., (2015)., “Removal of Crystal Violet Dye Using Sugarcane Fibre”, Transactions on Science and Technology, Vol. 2, No. 2, pp. 11 – 15.

[3] BaskerA., Shabudeen P. S. S., Daniel S. and Kumar P. V., (2014), “Adsorptive Removal of Malachite Green from Aqueous Solution Using Areca Husk Carbon”, RASAYAN Journal of Chemistry, Vol. 7, No. 1, pp. 1 – 15.

[4] Basu S., Kumari A., Abhigyan., Kumar R. and Das S., (2013), “Evaluating the Efficiencies of Naturally Available Low Cost Adsorbents for Removal of Methyl Red Dye”, International Journal of Current Research,Vol. 5, Issue. 11, pp.3328– 3334.

[5] Basu S., Juhi, Kavya H., Dash R. and Sumi., (2017), “Waste PisumSativum Pods as Adsorbent in Decolourizing Synthetic Dyes”, International Journal for Research & Development In Technology, Vol. 7, Issue. 6, pp. 237 – 239.

[6] Charles O. I. and Odoemelam S. A., (2010), “Studies on Adsorbent Dosage, Particle Sizes and pH Constraints on Biosorption of Pb(II) and Cd(II) Ions from Aqueous Solution Using Modified and Unmodified CrasstrotreaGasar (Bivalve) Biomass”, International Archive of AppliedSciences and Technology, Vol. 1, No. 1, pp. 62 – 68

[7] Fatiha M. and Belkacem B., (2016), “Adsorption of methylene blue from aqueous solutions using natural clay”, Journal of Materials and Environmental Science, Vol. 7, No. 1, pp. 285 – 292.

[8] Kartik J. P. M., Swathik H, Baskar U. S., Sivamani S., (2012), “Removal of Direct Red Dye Using Neem Leaf Litter”, Helix, Vol. 1, No. 2, pp 129 – 133

[9] Ladhe U. V. and Patil P. R., (2014), “Removal of Yellow 2G Dye from Aqueous Solutions Using Activated Carbon Prepared from Mosambi and Cotton asAgricultural Waste”, IOSR Journal of Environmental Science, Toxicology and Food Technology, Vol. 8, Issue. 1, pp. 49 – 54.

[10] Raghuvanshi S. P., Singh R. and Kaushik C. P., (2008), “Adsorption of Congo Red Dye from Aqueous Solutions using Neem Leaves as Adsorbent”, Asian Journa of Chemistry, Vol. 20, No. 7, pp. 4994 – 5000

[11] Rao M. N., Rao H., Chakrapani Ch., Babu Ch. S., Reddy B. V. R., Haritha P. and Rao K. S., (2011), “Adsorption studies of methylene blue dye using prepared low-cost activated Kaza’s Carbons”, Journal of chemical and Pharmaceutical Research, Vol. 3, No. 5, pp. 363 – 375.

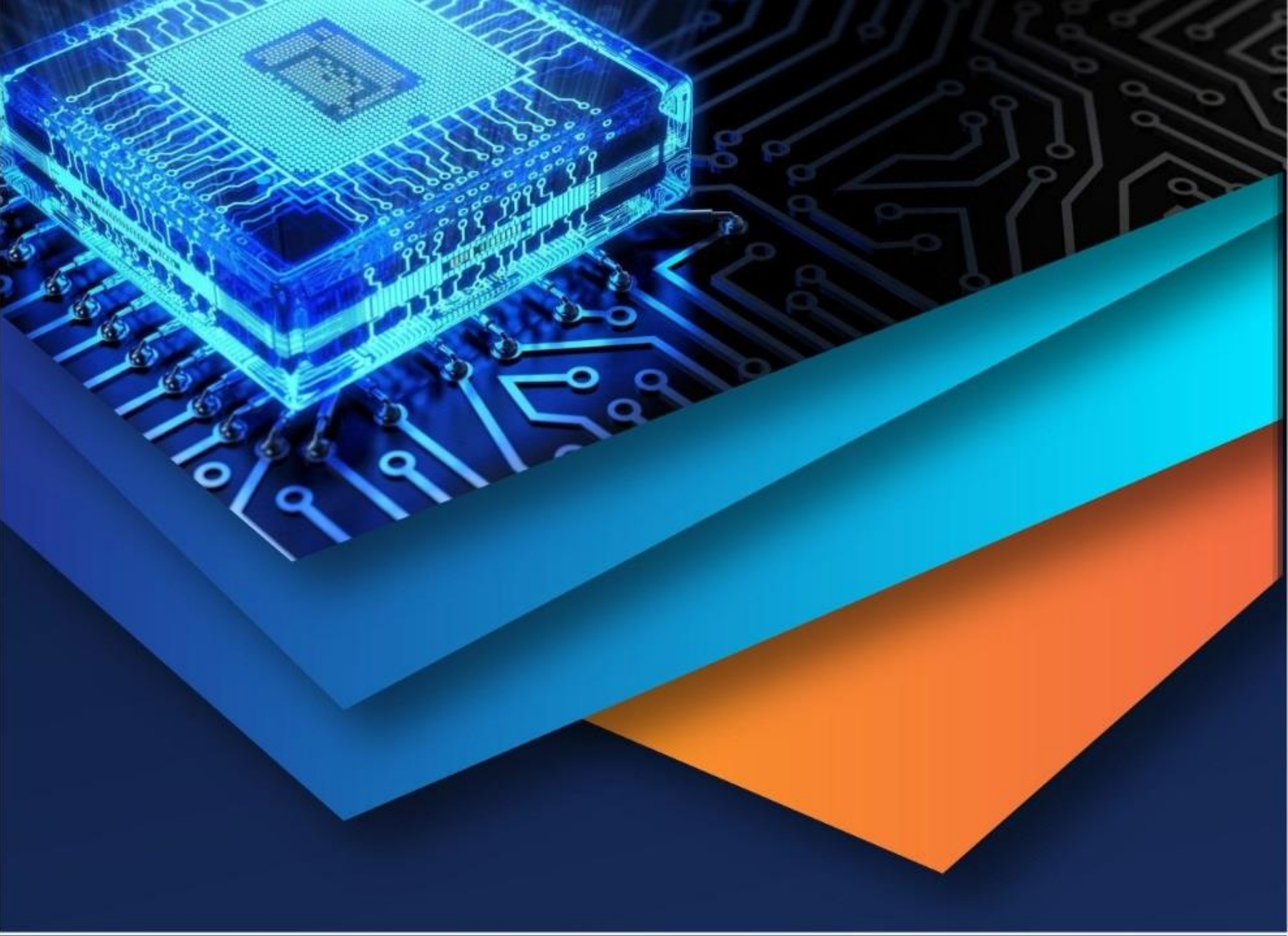
[12] Sharma A. and Bhattacharya K. G., (2005), “Utilization of a Biosorbent based on Azadirachtaindica(Neem) Leaves for Removal of Water- Soluble Dyes”, Indian Journal of Chemical Technology, Vol. 12, pp. 285 – 29

[13] Sharma S., Kaushal J. and Mahajan P., (2016), “Adsorption of Textile Dyes by Plant Biomass - A Review”, International Journal of Advanced Technology in Engineering and Science, Vol. 4, Issue. 3, pp. 143 – 152.

[14] Teka T. and Enyew S., (2014), “Study nn Effect of Different Parameters on Adsorption Efficiency of Low Cost Activated Orange Peels for the Removal of Methylene Blue Dye”, International Journal of Innovation and Scientific Research, Vol. 8, No. 1, pp. 106 – 11

[15] Tumin N. D., Chuah A. L., Zawani Z. and Rashid S. A., (2008), “Adsorption of Copper from Aqueous Solution byElaisGuineensis Kernel Activated Carbon”, Journal of Engineering Science and Technology, Vol. 3, No. 2, pp. 180 – 189

[16] Vinoth M., Lim H. Y., Xavier R., Marimuthu K., Sreeramanan S., Rosemal M. H. M. H. and Kathiresan S., (2010), “Removal of Methyl Orange from Solutions Using Yam Leaf Fibres”, International Journal of Chem Tech Research, Vol. 2, No. 4, pp 1892 – 1900.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY