INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue3)
Available online at www.ijariit.com

Comparative Study of Low Cost Adsorbents in the Elimination of Methylene Blue Dye from Aqueous Solutions

M. Padmaja
Mahatma Gandhi Institute of Technology
padmajamegham@gmail.com

R. Pamila
Mahatma Gandhi Institute of Technology
pamilaramesh@gmail.com

***Abstract**: Textile industries consume a large volume of water and chemicals for wet processing of textiles. As a result, produce large volumes of colored (dye) water as waste. The effectiveness of adsorption for dye removal from wastewaters has made it an ideal alternative to other expensive treatment options. The present study gives the preliminary experimental results using low-cost adsorbents viz; plantain flower petals, banana peels, snake gourd seeds, and egg shell in the eliminating methylene blue dye from aqueous solutions. The effect of various factors on the adsorption of the dye was studied in batch mode which includes pH, the concentration of adsorbent and dosage of adsorbents. The study revealed that plantain flower petals were very effective in the removal of methylene blue dye and about 99.7 % removal of dye was observed.*

Keywords: Adsorption, Banana Peels, Egg Shell, Methylene Blue, Plantain Flower Petals, Snake Gourd Seeds.

I. INTRODUCTION

Textile industry accounts for the largest consumption of dye stuff at nearly 80%. Many of these products are problematic because of their persistence in the environment and toxicity, though synthetic dyes have a wide application in the food, pharmaceutical, textile, cosmetics, and paper industries [1], [2]. Currently, there are about 10,000 different commercial dyes and pigments exist and over $7*10^5$ tons of synthetic dyes are produced annually worldwide. It is estimated that 10-15% of the dyes are lost in the effluent during the dyeing processes. Major problems associated with colored effluent are lowering light penetration, photosynthesis, and damages the aesthetic nature of the water surface. The presence of dyes in the water bodies lead to reduced dissolved oxygen content in water bodies and carcinogenic to human beings. A lot of de-colorization methods were developed using physical, chemical and biological techniques like Ion exchange, coagulation-flocculation, membrane separation, carbon absorption, aerobic treatment etc; [3]. However, most of the methods bear very high operation cost and some of them even need complex operation processes [4]. Adsorption was found to be the best method for removing dyes in the effluent. Much research was done to find the non-conventional low-cost absorbents such as bio-sorbent and natural materials which include clay materials, fruit peels, silica beads, rice husk, coconut shell, garlic peels, peat and biomass [5],[6],[7].

Adsorption makes use of waste biomaterials as adsorbents to remove dyes which make the de-colorization process inexpensive and environmental-friendly [8]. Biosorption is a newly developed method based on adsorption technique [9], [10], [11], [12]. So an attempt has been made to find out the suitability of bio-adsorbents from the wastes such as plantain flower petals, banana peels, snake gourd seeds, egg shell.

II. MATERIALS AND METHODS

A. Dye Preparation

The dye used here is methylene blue. For experimentation, initially, a stock solution was prepared at about 1000ppm concentration, by mixing 1g of methylene blue powder in 1000mL of distilled water. Then this solution was diluted further to get solutions of lower concentrations i.e. of 10ppm, 20ppm, 30ppm, 40ppm. The solutions were prepared in a 500mL conical flask and a weighed amount of adsorbent was taken.

B. Absorbent Preparation

1) Plantain Flower Petal

The petals are firm, slightly waxy, and erect when pulled a bit. The color is vibrant with hues of deep red and purple. They are the non-edible part of the plantain flower

Fig.1 Banana flower petal- raw, dried and powdered

2) Banana Peel

Bananas are consumed worldwide and a popular fruit with a yearly production of 145 million tons. India is the largest producer of bananas at 30 metric tons per year. Banana peels are sometimes used as feedstock for cattle, goats, pigs, poultry, and others. Nutritional value of the banana peel depends on the stage of maturity and the cultivar. For example, plantain peels contain less fiber than dessert banana peels and lignin content increases with ripening. On average banana peels contain 6-9% dry matter of protein and 20-30% fiber.

Fig.2 Banana peels- Raw, dried and powdered

3) Snake Gourd Seeds

Snake gourds are mostly grown in Asian countries and it consists of a number of nutrients and proteins with fewer calories hence it is used commonly in Asian countries there many types of snake gourd. As the snake gourd is larger the seeds will be more.

Fig.3 Raw snake gourd seeds, dried and powdered

4) Egg Shell

Annually 250000 tons of eggshell waste is produced worldwide. An egg shell is the outer covering of a hard-shelled egg and of some forms of eggs with soft outer coats. Bird's eggshells contain calcium Carbonate and dissolve in various acids, including the vinegar used in cooking. While dissolving, the calcium carbonate reacts with egg shell to form carbon dioxide. The egg is made almost entirely of calcium carbonate crystals. It is a semi-permeable membrane, which means that air and moisture can pass through its pores.

Fig.4 Raw egg shells, crushed and powdered

C. Batch Mode Adsorption Studies

Adsorption experiments were carried out in a batch process by using an aqueous solution of Methylene Blue Stock solution which is prepared by adding 1g of Methylene blue powder in 1000ml distilled water. Standard solutions were prepared by dilution of dye stock solution to about 10, 20, 30 and 40 ppm. The initial pH adjustment was carried out either by hydrochloric acid or sodium hydroxide solutions. The materials i.e. physical adsorbents are collected, dried and crushed into powder form. It is sieved in a 150µm sieve. The materials are dried in sunlight and also it is oven dried at 110º C. The adsorbents of a constant weight were taken and mixed with the standard solutions made. The suspensions were mixed at constant temperature (30º C) in an orbital shaker at 150 rpm till 1hour.The solution is left for settlement for about 24 hours. It is fully a natural settlement. It is filtered using "Whatman filter paper" and the absorbance and transmittance values for the filtered water were observed using UV-visible spectrophotometer at 664 nm wavelength.

1) Effect of pH on Methylene Blue Adsorption

The pH of the methylene blue solutions was adjusted to 3, 4, 9 and 10 pH values. The solutions were mixed with 0.5 g of each adsorbent of 150-micron particle size. The mixture was agitated at 30º C for one hour and left for 24 hours for settlement and was then filtered and the dye concentration was determined by measuring the absorbance of the solution at 664 nm.

The amount of dye adsorbed is calculated by the following formula:

$$q_e = (C_0 - C_e)\, \upsilon / m$$

Where q_e is the amount of dye adsorbed, C_0 and C_e are the initial and equilibrium dye concentrations (mol/L), respectively and m is the amount of adsorbent in g/L and υ is the volume of the solution in liters. The percentage uptake of the dye was calculated according to the following equation:

$$E = (C_0 - C_e) / C_0 \, X \, 100$$

E is the dye removal percentage (%)

2) Effect of Concentration on Methylene Blue Adsorption

The desired concentration range of about 10ppm, 20ppm, 30ppm and 40ppm was selected and fixed amount of adsorbent (0.5g) was added to these solutions. It was found that as the concentration of dye increased, adsorption also increased in some cases at room temperature 30º C.

3) Effect of Adsorption Dose on Methylene Blue Adsorption

To ascertain the effect of variation in the amount of adsorbent, 0.5g to 2g of the adsorbents namely eggshells, banana peels, plantain flower petals and snake gourd seeds each were taken in separate 500mL conical flasks having dye concentrations of about 100ppm at pH7.After 24 hours it was found that there was a considerable increase in adsorption with a decrease in the amount of adsorbent up to 0.1 g.

III. RESULTS AND DISCUSSION

A. %Removal

1) %Removal for pH

TABLE I
Comparison of adsorbents w.r.t. % removal

pH/Materials	Plantain Flower Petal	Banana Peel	Sanke Gourd Seed	Egg Shell
2	99.7	99.47	88.03	35.8
3	96.26	94.4	54.41	48.6
9	89.63	96.93	81.3	84.1
10	83.33	90.86	81.12	43.37

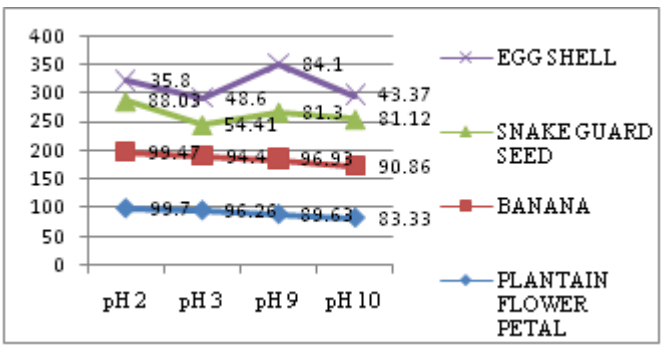

Fig. 4 Comparison of adsorbents w.r.t. % removal

2) %Removal for Concentration

Table .2
Comparison of adsorbents w.r.t. % removal

Concentration Of Materials	Plantain Flower Petal	Banana Peel	Snake Gourd	Egg Shell
10ppm	88.992	76.66	78.04	78.8
20ppm	93.203	98.8	75.119	50.5
30ppm	91.67	97.6	89.271	26.35
40ppm	96.18	96.94	89.585	32.35

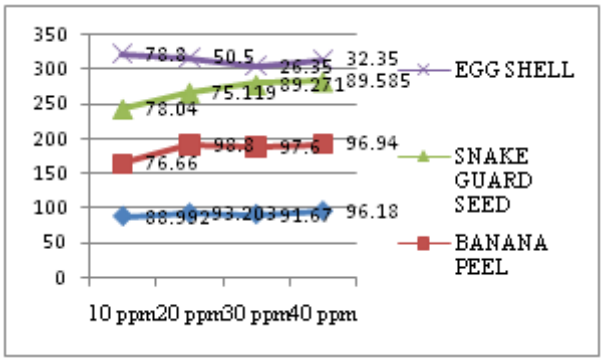

Fig.6 Comparison of adsorbents w.r.t. %Removal

3) %Removal for Dosage

Table .3
Comparison of adsorbents w.r.t. % removal

Dosage Of Materials	Plantain Flower Petal	Banana Peel	Snake Gourd Seed	Egg Shell
0.5g	88.99	93.01	78.04	64.83
1g	84.49	92.95	80.9	75.78
1.5g	81.94	94.49	66.7	79.52
2g	85.08	98.62	55.14	85.25

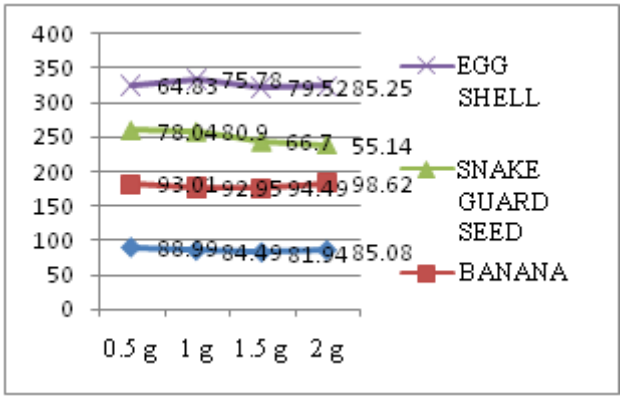

Fig.7 Comparison of adsorbents w.r.t. % removal

B. Amount of Dye Removed

1) Amount of Dye Removed for pH

Table.4
Comparison of adsorbents w.r.t. the amount of dye removed

pH/ Materials	Plantain Flower Petal	Banana Peel	Snake Gourd Seed	Egg Shell
2	0.2686	0.2678	0.237	0.0966
3	0.351	0.6884	0.1984	0.177
9	0.2628	0.2842	0.2384	0.2466
10	0.166	0.181	0.1616	0.086

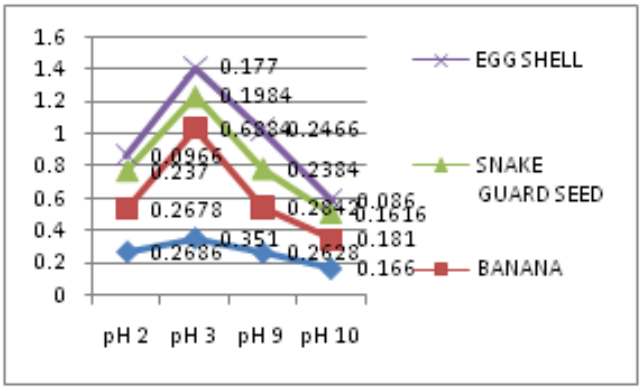

Fig.8 Comparison of adsorbents w.r.t. the amount of dye removed

2) Amount of Dye Removed for Concentration

Table.5
Comparison of adsorbents w.r.t. the amount of dye removed

Concentration /Materials	Plantain Flower Petal	Banana Peel	Snake Gourd Seed	Egg Shell
10ppm	0.3234	0.2762	0.2836	0.1662
20ppm	0.469	0.4948	0.378	1.144
30ppm	0.528	0.56	0.5142	0.0606
40ppm	0.761	0.7646	0.7088	0.0178

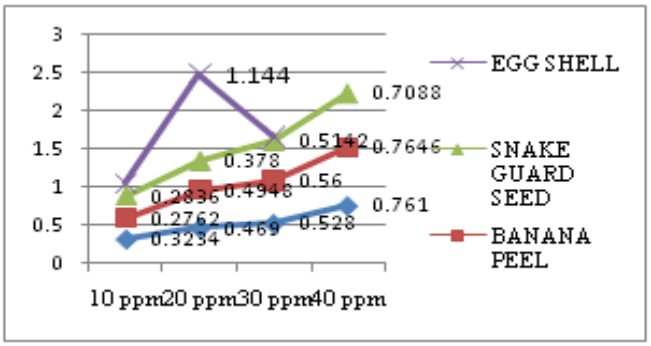

Fig.9 Comparison of adsorbents w.r.t. amount of dye removed

3) Amount of Dye Removal for Dosage

Table.6
Comparison of adsorbents w.r.t. the amount of dye removal

Dosage/ Materials	Plantain Flower Petal	Banana Peel	Snake Gourd Seed	Egg Shell
0.5g	0.3234	0.2762	0.2836	1.1662
1.0g	0.3086	0.3378	0.297	0.2754
1.5g	0.2978	0.3434	0.2424	0.289
2.0g	0.3092	0.3584	0.2004	0.3098

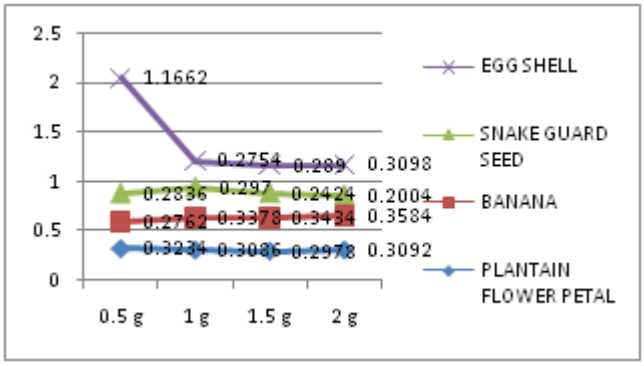

Fig. 10 Comparison of adsorbents w.r.t. the amount of dye removal

In the case of concentration of dye, banana peels were very much effective in the removal of colors to about 96.94% at 40ppm concentrations. In the case of dosage of the adsorbent, banana peel was very much effective in removing colors to an extent of about 98.62% at about 2g. In the case of pH, plantain flower petals were very much effective in color removal with about 99.7% at acidic pH 2-3. Snake gourd seeds were very much effective in removing colors to at the basic pH of 9-10. Egg shells were also very much effective in removing the colors when used at 2g in lower concentrations of about 1ppm and 2ppm.

CONCLUSION

The efficiency of the snake gourd seeds, banana peels, egg shells and plantain petals in removing methylene blue from the aqueous solution with concentrations 10ppm, 20ppm, 30ppm and 40ppm was in the order of Plantain petals >Banana peels > Snake gourd seeds > Eggshell. The efficiency of the adsorbents in removing methylene blue from its aqueous solution of 10ppm concentration at acidic pH 2-3 was in the order of Banana peels > Plantain flower petals > Snake gourd seeds > Egg shell. Similarly for basic pH of range 9-10 the order is of Snake gourd seeds > Banana peels > Plantain flower petals > Egg shell.
Hence among all the four adsorbents plantain flower petals were very much effective in all the parameters with about 99.7 % removal of dye.

REFERENCES

[1] Abdel-Halim SH, Shehata AMA, El-Shahat MF. *Removal of lead ions from industrial wastewater by different types of natural materials*. Water Research. 2003; 37:1678– 1683.
[2] J.R. Memon, S.Q. Memon, M.I. Bhanger, A. El-Turki, K.R. Hallam, G.C. Allen, *Banana Peel: A green and economical sorbent for the selective removal of Cr(VI) from industrial wastewater*, Colloid and Surface B: Biointerfaces 70 (2009) 232-237.
[3] Yagub, Mustafa T., et al. "*Dye and its removal from aqueous solution by adsorption: a review*." *Advances in colloid and interface science* 209 (2014): 172-184.
[4] Forgacs, Esther, Tibor Cserhati, and Gyula Oros. "Removal of synthetic dyes from wastewaters: a review." *Environment International* 30.7 (2004): 953-971.
[5] Robinson, Tim, et al. "Remediation of dyes in textile effluent: a critical review on current treatment technologies with a proposed alternative." *Bioresource Technology* 77.3 (2001): 247-255.
[6] Crini, Gregorio. "Non-conventional low-cost adsorbents for dye removal: a review." *Bioresource Technology* 97.9 (2006): 1061-1085.
[7] Pavan, Flavio Andre, Ana Cristina Mazzocato, and Yoshitaka Gushikem. "Removal of methylene blue dye from aqueous solutions by adsorption using yellow passion fruit peel as an adsorbent." *Bioresource Technology* 99.8 (2008): 3162-3165.
[8] Hameed, B. H., and A. A. Ahmad. "Batch adsorption of methylene blue from aqueous solution by garlic peel, an agricultural waste biomass." *Journal of Hazardous Materials* 164.2 (2009): 870-875.
[9] Ramakrishna, Konduru R., and T. Viraraghavan. "Dye removal using low-cost adsorbents." *Water Science and Technology* 36.2-3 (1997): 189-196.
[10] Kadirvelu, Kavipriya, et al. "Utilization of various agricultural wastes for activated carbon preparation and application for the removal of dyes and metal ions from aqueous solutions." *Bioresource Technology* 87.1 (2003): 129-132.
[11] El-Geundi, Mohammad S. "Colour removal from textile effluents by adsorption techniques." *Water Research* 25.3 (1991): 271-273.
[12] Uddin, Md Tamez, et al. "Adsorptive removal of methylene blue by tea waste." *Journal of Hazardous Materials* 164.1 (2009): 53-60.

