Comparative study on removal of basic violet dye using pomegranate peel and Prosopis Juliflora

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***Abstract*— The discharge of dye-laden wastewater from the textile sector has a significant impact on water pollution, creating environmental challenges. This contamination generates extensive effluents containing various dye compounds, which alter the environmental conditions. To address this issue, there is a growing need to develop alternative adsorbents using economically feasible raw materials such as locally sourced industrial waste and mineral by-products. A recent study focused on using pomegranate peels and Prosopis Juliflora as adsorbents for dye removal, comparing their adsorption capacities and delineating the adsorption mechanisms using isotherm models. Batch experiments were conducted to evaluate the adsorption capacity of different adsorbents at different doses (0.5, 1, 1.5, 2 and, 2.5 g/100) and initial adsorbate concentrations of 50mg/L. The study examined the adsorption capacity of pomegranate peels and Prosopis Juliflora for basic violet dye in simulated wastewater. The results showed that pomegranate peel exhibited maximum efficiency at an adsorbent dosage of 15 g/l. Optimization studies were conducted, which identified pH 3, a contact time of 20 minutes, and a rotational speed of 120 rpm as the optimal conditions for achieving maximum removal efficiency. Prosopis Juliflora exhibited maximum efficiency at an adsorbent dosage of 15g/l, with subsequent optimization identifying pH 7, a contact time of 15 minutes, and a rotational speed of 120 rpm as the conditions yielding maximum removal efficiency. By adjusting the adsorbent dosage, pH, contact time, and rotational speed, the highest removal efficiency of basic violet dye was discovered. Prosopis Juliflora demonstrated the highest adsorption capacity at 92%, while pomegranate peel demonstrated an adsorption capacity of 82%. Based on this study, it can be inferred that adsorbents derived from Prosopis Juliflora and pomegranate peels can serve as alternative agents for pollutant removal from aqueous environments.**

Keywords: Adsorption, Prosopis Juliflora. Pomegranate peel

I. INTRODUCTION

Textile wastewater generated by wet processing operations such as de-sizing, scouring, bleaching, dyeing, printing, and finishing can contribute significantly to water pollution. The dyeing and washing processes are responsible for most of the color in textile wastewater, with up to 50% of the dye being released into the effluent. Although most of the dye is exhausted during the dyeing process, unfixed dye that enters the wastewater causes a deep color and makes the composition of the wastewater highly variable due to the large number of dyes and other chemicals used in processing. Different dyes are used based on the fiber's characteristics, the specific color to be applied, and the desired finish. The removal of color from effluent is a significant challenge for the textile industry because even a small fraction of dyes in water is highly visible, affecting the aesthetic merit of streams and other water resources. Most dyes have complex aromatic structures that are resistant to light, biological activity, ozone, and other degradative environments, making them challenging to remove by typical waste treatment. Dyes and dye degradation products have possible long-term effects, and the allergenic effects of dyes have been confirmed. Improperly treated dyes may harm aquatic life due to reduced light penetration and the presence of metals and chlorides in them. Dyes have also been known to interfere with certain municipal wastewater treatment operations, such as UV disinfection. Therefore, textile industries need to treat their wastewater to reduce the adverse environmental impacts and health hazards caused by discharging untreated wastewater.

Various physical, chemical, and biological treatment methods are being used to remove organic, inorganic, and biological pollutants from wastewater. Different techniques have been employed to remove harmful dyes from colored wastewater, such as chemical coagulation/flocculation, precipitation, adsorption, oxidation, ion exchange, photodegradation, and ozonation. Adsorption is an effective process for removing coloring matter from effluents. It is a phenomenon that involves attracting and retaining the molecules of a substance on the surface of a liquid or solid, resulting in a higher concentration of the molecules on the surface.

II. OBJECTIVE

- The purpose of this study is to assess the ability of Pomegranate peel and Prosopis Juliflora to remove Basic Violet from synthetic wastewater through adsorption.
- Determining the optimal conditions for the removal of Basic Violet from synthetic wastewater, including the impact of pH, contact time, adsorbent dose, and initial Basic Violet concentration.
- Evaluating the adsorption studies to determine the efficiency of Prosopis Juliflora and Pomegranate peel as adsorbents in removing Basic Violet from synthetic wastewater.

III. EXPERIMENTAL ANALYSIS

The raw Prosopis Juliflora leaf and pomegranate peel were collected from the rural areas surrounding Kallathur, Jayankondam, and Ariyalur districts. It was characterized by determining moisture content, pH. EC. This analysis will be conducted and results slightly confirms removal of pollutant in water.

Basic Violet is a triaminotriphenylmethane dye, which was purchased from Madurai. The molecular weight of the basic violet dye is 407.98 mg/mol. The absorption wavelength of basic violet is 589 nm.

It is important to remove it from industrial wastewater before discharging it into the environment. It can cause allergies such as contact dermatitis and respiratory diseases, allergic reactions in the eyes, skin irritation, and irritation to mucous membranes and the upper respiratory tract. Basic violet dye is highly hazardous as its exposure may cause permanent blindness and kidney failure.

Table 4.1 Initial characteristics of adsorbents

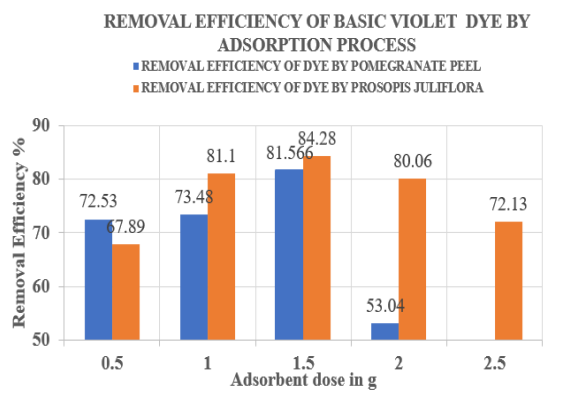
PARAMETER	PROSOPIS JULIFLORA	POMEGRANATE PEEL
pH	6.12	5.07
Moisture content	0.115%	0.107%
Electrical conductivity	0.23 µS/cm	0.55 µS/cm
Ash content	4.85%	9.92%

IV. BATCH STUDY

Batch experiments are carried out using a series of 250 ml conical flasks to investigate the effects of contact time, pH and adsorbent dosage on the adsorption of basic violet dye solution. Know amounts of Prosopis Juliflora and pomegranate peel powder are added to the solution. The mixture is stirred gently using a rotary shaker at room temperature. The suspensions are filtered using Whatman filter paper No. 541, and the concentrations of the dye solution are measured using UV-spectrophotometer at wavelength of 589nm. The effects of various parameters on percentage of adsorption were observed by varying contact time, pH of solution and adsorbent dosage

REMOVAL EFFICIENCY IN VARIATION OF DOSAGE (POMEGRANATE PEEL AND PROSOPIS JULIFLORA)

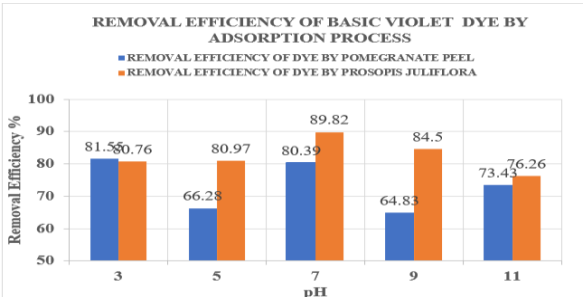
Figure 4.1 Effect of dosage



The above graph is plot between dosage and removal efficiency of basic violet dye where, Prosopis Juliflora gives more removal efficiency.

REMOVAL EFFICIENCY IN VARIATION OF pH (POMEGRANATE PEEL AND PROSOPIS JULIFLORA)

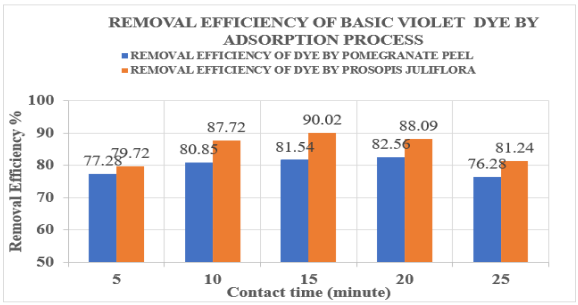
Figure 4.2 Effect of pH



The Maximum percentage of dye removal by these adsorbents are achieved at pH of 3 (pomegranate peel) and 7 (Prosopis juliflora).

REMOVAL EFFICIENCY IN VARIATION OF CONTACT TIME (POMEGRANATE PEEL AND PROSOPIS JULIFLORA)

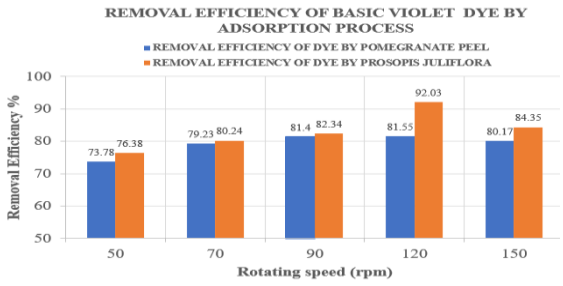
Figure 4.3 Effect of Contact time



From the results it can be concluded that an equilibrium period of 15minutes for Prosopis juliflora are required for maximum dye removal.

REMOVAL EFFICIENCY IN VARIATION OF ROTATING SPEED OF ROTARY SHAKER (POMEGRANATE PEEL AND PROSOPIS JULIFLORA).

Figure 4.4 Effect of speed of rotary shaker



From the results it can be concluded that adsorbents efficiently remove dye at 120rpm of rotating speed.

V.RESULT AND DISCUSSION

ISOTHERM STUDIES

Adsorption isotherm described the relationship between amounts of adsorbate onto the adsorbent and so understand the nature between adsorbate and adsorbent from isotherm model, namely Freundlich, Langmuir were applied. Basic violet adsorption was investigated using the following parameters 1.5g/100ml, pH 3, 20 minutes of contact duration and 120 rpm rotation speed. The values for the adsorption (log(x/m) against the (log Ce) show the types of adsorptions. There are four options for separation factors as the favourable adsorption at 0<R< 1 unfavourable adsorption at R>1, linear adsorption at Ris equal 0. Since the R value of this study was between 0 and1 (0<R<1) which indicated that the adsorption process favourable.

Figure 4.5 Isotherm study derived using pomegranate

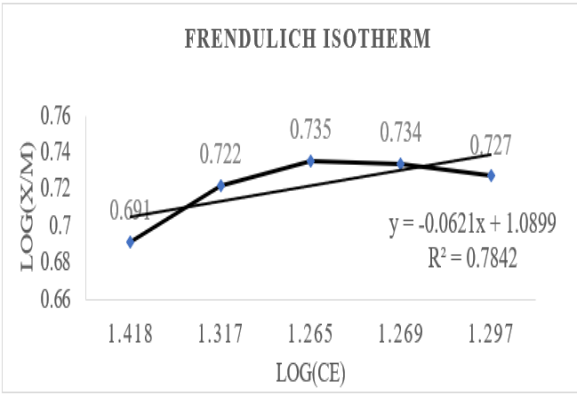
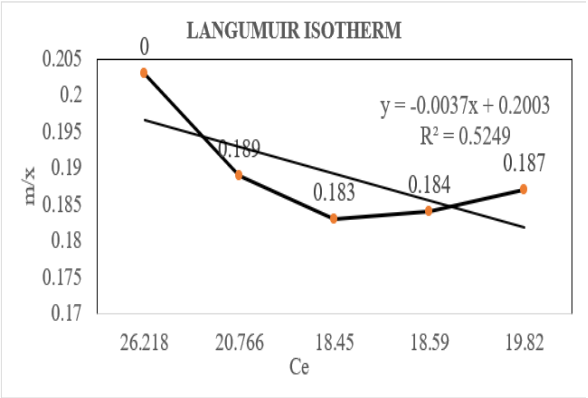


Figure 4.6 Isotherm study derived using pomegranate



The adsorption of basic violet dye on pomegranate peel follows the Freundlich isotherm with good correlation coefficient R^2 i.e, 0.7842.

Figure 4.7 Isotherm study derived using Prosopis juliflora

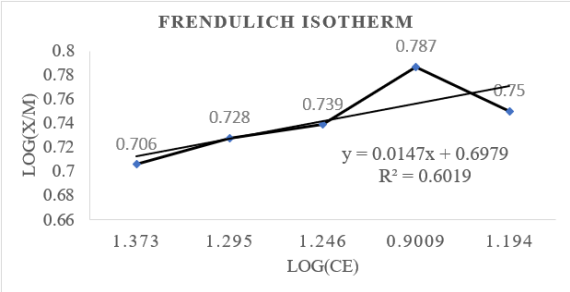
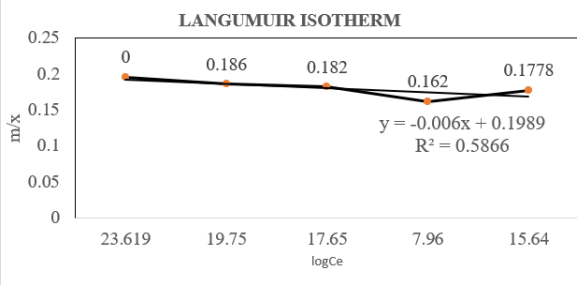


Figure 4.8 Isotherm study derived using Prosopis juliflora.



The adsorption of basic violet dye on Prosopis juliflora follows the Freundlich isotherm with good correlation coefficient R^2 i.e, 0.601.

IV. CONCLUSION

The following conclusion has been derived from the study on investigation on the removal efficiency of basic violet dye using pomegranate peel and Prosopis Juliflora in adsorption method.

1. The comparison study of adsorption of basic violet by pomegranate peel and Prosopis Juliflora was conducted, in which effect of adsorption dose, Ph, contact time and mixing speed was found higher than pomegranate peel.
2. For Pomegranate peel, the highest removal of basic violet (82.56%) was achieved using 1.5g of Pomegranate peel at pH 3 and contact time of 20 minutes and speed of 120rpm. For Prosopis Juliflora the highest removal of basic violet dye (92.03) was achieved using 1.5g of Prosopis Juliflora at pH 7 and contact time of 15 minutes and speed of 120 rpm.
3. The results indicate that each adsorbent has an ability to remove the basic violet dye from aqueous solution. Prosopis Juliflora is the best to remove basic violet dye compared to Pomegranate peel. It showed 92% of removal efficiency. Adsorbents from the Pomegranate take next place. It showed 82.56% of removal efficiency.
4. Where Freundlich adsorption model confirms favorable adsorption occur during adsorption process.

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