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STUDY OF CONTACT TIME ON EFFECTIVENESS OF NATURAL ADSORBENTS TO ADSORB CRYSTAL VIOLET DYE

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Abstract:

Synthetic dyes are used for colouring in textile, leather and manufacturing industries and these are water soluble and produce very bright colours in water. When it is discharged without treatment, it leads to pollution. This research gives an insight into the adsorption studies with a focus on time of contact on the efficiency of decolourizing Crystal Violet dye with natural adsorbents (*Citrullus lanatus* Peel*, Citrullus lanatus* Rind *and Citrus limetta* Peel). This study reveals that *Citrullus lanatus* Rind can effectively decolourize 52.2% Crystal Violet dye at concentration of 50 mg/L with lower contact time of 60 min and at 120 min, 67.7% dye removal is achieved. At increased initial dye concentration of 75 mg/L and 100 mg/L, *Citrullus lanatus* Peel is effective in decolourizing Crystal Violet dye at lower contact time of 60 min and percentage dye removal is 67.4% and 65% respectively. At high initial dye concentration of 125 mg/L, high contact time of 120 min with *Citrullus lanatus* Peel is required to remove 58.8% Crystal Violet Dye. As compared with these two adsorbents, *Citrus limetta* Peel is not very effective in adsorbing Crystal Violet Dye.

Keywords: *Citrullus lanatus* Peel*, Citrullus lanatus* Rind *and Citrus limetta* Peel, Adsorbents

Introduction

The synthetic dyes are chemical compounds which create havoc in the environment if untreated and let into water bodies because these are water soluble, retain in the environment, are difficult to degrade due to their complex aromatic structures, pollute the water bodies, affect aquatic life, enter into food webs and have carcinogenic and mutagenic effects (Vinoth *et al*., 2010; Abbas *et al*., 2011; Karthik *et al*., 2012). Most of these are azo dyes and the presence of one or several azo (–N=N–) groups associated with substituted aromatic structures impart bright colour (Vinoth *et al*., 2010). Amongst various physical techniques to decolourize dyes, adsorption has gained prominence due to its effectiveness and efficiency for the removal of colour from the wastewater (Sharma *et al*., 2005; Karthik *et al*., 2012). However, the traditional adsorption technique employing solid activated carbon is costly and the modern focus is on the use of natural adsorbents. This research is focused on the effect of contact time with waste natural adsorbents like Watermelon (*Citrullus lanatus*) Peel and Rind and Musambi (*Citrus limetta*) Peel in decolourizing the synthetic dye, Crystal Violet.

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2. Materials and Methodology

2.1 Preparation of Adsorbent

Citrullus lanatus Peel and *Citrus limetta* Peel are collected from Sir MVIT canteen and are thoroughly washed with distilled water. The *Citrullus lanatus* Rind is carefully removed from the Peel and all these are dried under the sun until these have become crisp so as to crush these separately into powder form in mixer and are passed through a 0.246 mm sieve to obtain uniform particle size of adsorbents. The size of the sieve is chosen according to the study by Karim *et al.*, 2015. The adsorbents are then stored in air tight containers.

2.2 Preparation of Adsorbate

A stock solution of Crystal Violet dye is prepared by dissolving 0.5 g of dye in 1 L distilled water and stored in volumetric flask.

2.3 Batch Studies on Contact Time

Aliquots of the dyes are prepared to obtain solutions with concentrations 50 – 125 mg/L. The volume is made to 100 mL. These dyes are taken in 250 mL conical flasks and 0.5g of three adsorbents are weighed separately and added to each conical flask. The solutions are agitated at a speed of 240 wrist action per minute using Secor India Griffin Flask Shaker for 60 minutes, 90 minutes and 120 minutes at a constant room temperature of 33^0C. After the stipulated time, the adsorbate is filtered out using ordinary filter paper from each of the conical flasks in order to get a clear solution. Optical Density is measured at 650 nm using Systronics Spectrophotometer (Model-106). The process is repeated again for all the adsorbents.

The percentage removal of adsorbate 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)

3. Results and Discussion

Figure 1 shows that with 0.5 gm and 0.246 mm *Citrus limetta* Peel adsorbent, the percentage dye removal for Crystal Violet dye at initial concentration of 50 mg/L and is found to be 20.5%, 23% and 24.5% at contact time of 60 min, 90 min and 120 min respectively. Substantial increase in percentage dye removal has been seen at initial concentration of dye at 75 mg/L and it is 25.5%, 36.4% and 37.3% at contact time of 60 min, 90 min and 120 min respectively. This can be due to the availability of more time for the dye to form an attraction complex with the adsorbents. This is similar to the findings of researchers Abbas *et al.,* 2011 and Karthik *et al.,* 2012, Basu *et al.*, 2017. However, the percentage dye removal is almost constant even with increase in contact time at higher initial dye concentration of 100 mg/L and 125 mg/L at 24.5 % and 29% respectively. This may be due to the fact that equilibrium is reached and also the binding of functional groups on the surface of adsorbent by dye may be weak. This is similar to the work by Said *et al.,* 2014.

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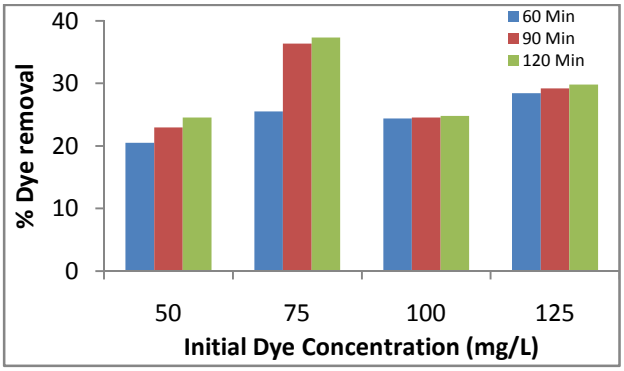

Figure 1 Percentage Dye Removal of Crystal Violet Dye with *Citrus limetta* Peel Adsorbent Dose of 0.5 gm and size 0.246 mm

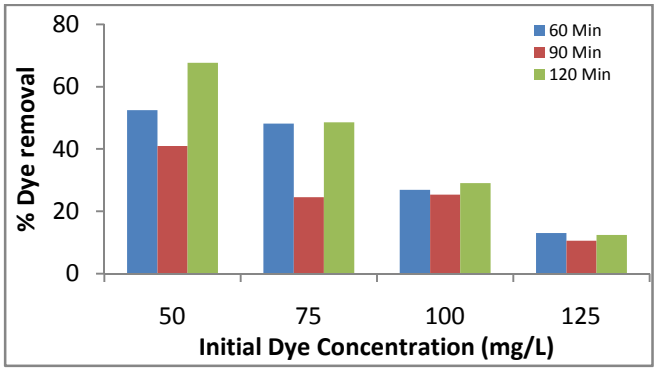

Figure 2 Percentage Dye Removal of Crystal Violet Dye with *Citrullus lanatus* Rind Adsorbent Dose of 0.5 gm and size 0.246 mm

Figure 2 shows the percentage dye removal of Crystal Violet dye with *Citrullus lanatus* Rind adsorbent dose of 0.5 gm and size 0.246 mm. At initial concentration of 50 mg/L, the percentage dye removal at 60 min is 52.5% and increases to 67.7% at 120 min. *Citrullus lanatus* Rind shows a dye removal percentage of 48.2% at 60 min with initial dye concentration of 75 mg/L which decreases at 90 min and increases and remains constant at 48.6% at 120 min. This may be because equilibrium might be reached at 60 min itself. With increase in initial concentration to 100 mg/L, the dye removal percentage is almost constant and varies from 27% to 29.1% even with increase in contact time from 60 min to 120 min. At 125 mg/L the dye removal percentage is very low and is 13% at 60 min contact time and 12.4% at 120 min contact time.

Figure 3 shows the changes in percentage of dye removal from initial to final concentration of dyes with *Citrullus lanatus* Peel adsorbent dose of 0.5 gm and size 0.246 mm with varying contact time. At initial concentration of 50 mg/L, there has been a sharp decline in percentage dye removal from 49.1% at 60 min to 9.9% at 120 min. Similarly a decline is observed from 60 min to 120 min at initial dye concentration of 75 mg/L and 100 mg/L but the rate of decline is low from 67.4% to 56.6% and 65% to 52.5% respectively. This may be due to the dyes remaining in solution as binding of functional groups on surface of adsorbent is weak, similar to study by Said *et al.,* 2014. However, at initial dye concentration of 125 mg/L, a slight increase in percentage dye removal is observed with increase in contact time from 56.6% at 60 min to 58.8% at 120 min. This is because the adsorbed dye molecules tend to increase adsorption of other molecules. This is similar to the work done by Vinoth *et al.,* 2010. Also more time becomes available for the dye to make an attraction complex with

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the adsorbents. This is similar to work carried out by Abbas *et al.,* 2011 and Karthik *et al.,* 2012, Basu *et al*., 2017.

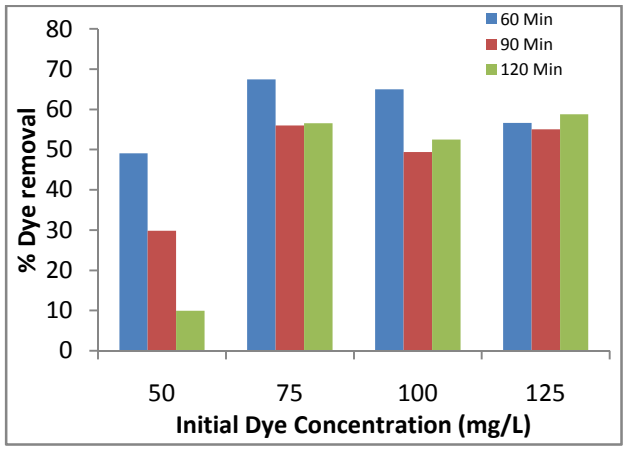

Figure 3 Percentage Dye Removal of Crystal Violet Dye with *Citrullus lanatus* Peel Adsorbent Dose of 0.5 gm and size 0.246 mm

4. Conclusion

This study reveals that *Citrullus lanatus* Rind is effective in decolourizing 52.2% Crystal Violet dye at concentration of 50 mg/L with lower contact time of 60 min and at 120 min, 67.7% dye removal is achieved. At increased initial dye concentration of 75 mg/L and 100 mg/L, *Citrullus lanatus* Peel is effective in decolourizing Crystal Violet dye at lower contact time of 60 min and percentage dye removal is 67.4% and 65% respectively. At high initial dye concentration of 125 mg/L, high contact time of 120 min with *Citrullus lanatus* Peel is required to remove 58.8% Crystal Violet Dye. As compared with these two adsorbents, *Citrus limetta* Peel is not very effective in adsorbing Crystal Violet Dye

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