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Time Dependent Effect of Bioadsorption of Dyes by Fruit and Vegetable Peels

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Abstract: Effluents cause a significant amount of pollution which is let out from several industries. One such cause is the textile dying industry which pollutes the surrounding water bodies with the colors and dyes. Several chemicals are used to purify or decolorize that water so that it can be used for other purposes. However, instead of using bleaching agents and chemicals, biological materials like farm waste, agro waste can help achieve a cleaner environment. In this pursuit, six different samples namely sweet lime, watermelon, bitter gourd, papaya, corn and radish skin peels were used as samples and exposed to commercial dyes for a duration of 3 hrs, 6 hrs and 9 hrs to observe the degree of adsorption. The powder of all the 6 samples were prepared and added to 5 different dyes like methylene blue, malachite green, methyl orange, crystal violet and crystal red.
Keywords: dyes, water pollution, agro waste, malachite green, crystal violet.

Introduction:

The residues from dying industry are considered a wide variety of organic pollutants introduced into the natural water bodies or into the wastewater treatment system [1]. Some chemical or physical processes like coagulation, flocculation, fenton process, ozonation, adsorption have been used for the removal of synthetic dyes from industrial effluent [2]. Even a concentration as low as 1 mg/L will make the water unfit for drinking and will show a change in the color [3]. The environment authorities have begun to target the textile industry to clean up the wastewater by looking for the effect of toxicity like high salt content, high dissolved or suspended solids, biological and chemical oxygen demand etc [4]. All this leads to high potential health risks leading to gastrointestinal tract, skin and lung disorders and also causes disturbances in the blood formation [5]. It reduces the sunlight penetration which is harmful for aquatic life. It can be toxic, carcinogenic or mutagenic in nature [6]. Common pollutants present in dye effluents are detergents, sizing agents, caustic, oils, latex, glues, in organic compounds and wide variety of special chemicals of which some may be basic or acidic in nature [7]. Therefore, adsorption of these dyes by common agricultural by products has been proved to be a very cost effective, realistic method for the removal of different pollutants like dyes, heavy metals, gasses etc [8]. The objective of the present study was to understand the level of dye degradation or adsorption in the presence of 6 different vegetable and fruit peels at different time periods (3 hrs, 6 hrs and 9 hrs). The samples chosen for the study are *Citrullus lanatus (*Watermelon), *Citrus limetta*(Sweet lime), *Momordica charantia* (Bitter gourd), *Carica papaya* (Papaya), *Zea mays* (Corn), and *Raphanus sativa* (Radish). Similar study with different samples have shown exemplary effects in the past [9] Algae have efficiency to remove a heavy metals from electroplating industry optimum temperature, pH, contact time, different concentration was reported [10].

Materials and Methods:

Preparation of sample: The samples were collected from the local market and was washed thoroughly with tap water. Later washed with distilled water and blotted on a blotting paper. Then the peel was removed and diced into small pieces and it was dried under shade. After which it was ground into a fine powder and stored for the experiment.

Preparation of the dye: One mg of the powder of each of the samples was dissolved in 1 L of solution containing 1 mL of dye. This step was repeated for all the 5 dyes and all the 6 samples. It was kept in a rotary shaker for 3 hrs and then the absorption was measured using a UV spectrophotometer. The same step was repeated at the sixth hour and ninth hour also. The following formula was used for the calculation of the adsorption rate. With the values obtained, graph was drawn as shown in Figure 1.

$$\text{Degradation (\%)} = \frac{\text{Initial adsorbance value} - \text{Observed adsorbance value}}{\text{Initial adsorbance value}} \times 100$$

Results and Discussion:

The study was carried out at different time intervals allowing the substrate to be in contact with the dye. Contact time is the one of the important parameters. In this study 3 hr, 6 hr and 9 hr was considered for degradation rate. Figure 1 shows the degradation rate of the 5 different dyes at 3 different time intervals. Malachite green, methylene blue, methyl orange, congo red and crystal violet shows maximum degradation in 9 hrs. Degradation efficiency increases in contact time between adsorbent and adsorbate. It can be attributed to the fact that more time becomes available for the dye to make attraction complex with orange peel [11]. In all the 6 samples chosen in the present study, it is evident that the percentage of dye degradation is comparatively lesser with lower exposure time as 3 hr or 6 hr. However, *Zea mayes* showed the maximum adsorption with respect to all the dyes at all time intervals compared to the other samples. Irrespective of the dye used, all of powder have better degradation value with longer exposure time. It is evident from another study [12] that as the contact time between dye and adsorbent increased, degradation rate also increased. Similar trend was observed [13] in mango peel was used as an adsorbent. Reaction time increased with increase of degradation rate from 50% to 88%. In the case of *Carica papaya*, methyl orange and crystal violet showed only 10% of degradation followed by *Momordica charantia* in the presence of crystal violet. However, the other dyes in the presence of other extracts showed better values. All the 6 samples showed maximum dye degradation at 9 hrs followed by 6 hrs and finally at 3 hrs. This may be attributed to the contact time and the characteristics of the adsorbent and dye concentration. Similar trend was observed by [14] the adsorption of dye rate increased with increase in time to reach equilibrium. It has been proved that increase in removal efficiency increases with contact time [15]. In some cases, in the initial stages there is more surface for the dye to get adsorbed and so it is faster but as the time progresses adsorption slows down [16].

Conclusion:

Vegetable and fruit peels can be used as a good source to cleanse the effluent from dying industries instead of using physical or chemical methods since this method is more reliable and very cost effective. At the same time does not render any harmful effects to the environment. Hence, in order to purify the environment which is continuously being polluted one can use the vegetable and fruit peels which have an excellent potential to adsorb the dye particles and make the water colorless or decrease the intensity of color to some extent.

Legend for the folowing graph: Malachite green (MG), Methylene blue (MB), Methyle Orange (MO), Crystal violet (CV), Congo red (CR).

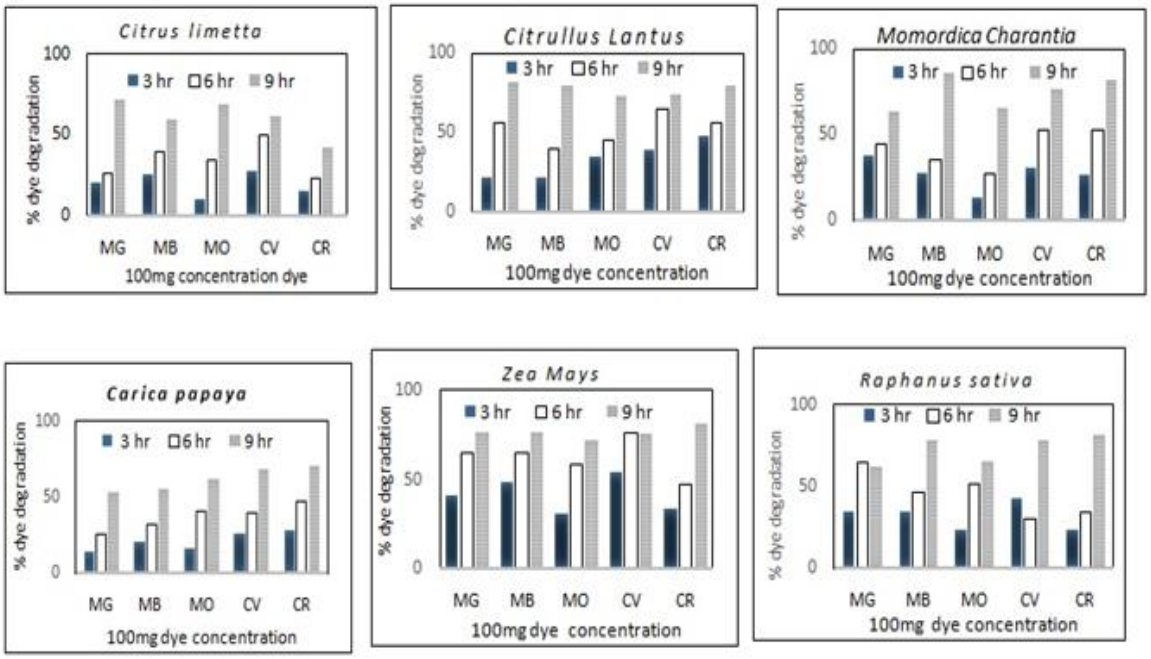

Figure1: Time dependent effect of adsorption of dyes using vegetable and fruit peels

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