CHAPTER V

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The following ten common leather dye solutions of varying concentrations were studied using three different bio-wastes and a sample of commercially available activated carbon as adsorbents:

1. Acid Blue 193
2. Acid Blue 92
3. Acid Blue 41
4. Basic Green 4
5. Acid Green 20
6. Acid Yellow 36
7. Acid Yellow 42
8. Reactive Yellow 44
9. Basic Orange 2
10. Acid Red 18

It was found that:

- More amount of dye was adsorbed on cow dung and parthenium leaves ash as compared to mango stone ash and activated carbon.
- Adsorption was higher at acidic pH.
- Adsorption followed both Langmuir and Freundlich isotherms.

Different number of pores or adsorption sites are available on different samples of carbon or any adsorbent for that matter. This was true for the sample of bio-wastes as well as activated carbon used in this study. Dye adsorption on cow dung and parthenium leaves ash was higher as compared to mango stone ash and activated carbon. This behavior can be attributed to the relationship between the effective surface area of the adsorbent particles and their sizes. The bio-wastes had a smaller particle size than the activated carbon used. Surface area of the activated carbon was 600 m$^2$/gm and its bulk density was 600-1000 mg/L while the bio-wastes were used in the form of ash (-70 microns.) The effective surface area increased as the particle size decreased and consequently the saturation capacity per unit of mass adsorbent increased. For small particles a large external surface area is presented to the
dye molecules in solution which results in a lower driving force per unit surface area for mass transfer than when larger particles are used [62, 132].

Al-Dega et al. [13] have also explained that differences in capacities of adsorbents for same adsorbate are caused by their surface properties. The surface of adsorbent materials can contain not one but at least five markedly different types of surface groups such as carboxylic, lactonic, phenolic, carbonyl, and etheric types. Different samples of activated carbon can show higher or lower adsorption capacity towards a range of organic dyes/pollutants. This reactivity arises from the complexity of the chemical surface.

The maximum removal of dyes was observed at acidic pH. At acidic pH values, the adsorbent tends to form an aqua complex to yield a positively charged surface. The ionic dye consequently releases colored dye anions/cations in solution, which in turn is influenced by the solution pH agents [170]. There is an increase in concentration of the \( \text{H}^+ \) ions in dye solution at acidic pH. The \( \text{OH}^- \) ions on adsorbent surface tend to be neutralized by protonation which facilitates the diffusion of dye molecules in the vicinity of the adsorbent.

The positively charged surface sites on the adsorbent favor the adsorption of dye anions due to the electrostatic attraction. Thus the surface charge on the adsorbent and the solution plays a significant role in influencing the capacity of an adsorbent towards dye ions. Having an excess positive charge on their surface activated carbon had a greater capacity to adsorb dyes when the solutions were made acidic.

Lower adsorption at alkaline pH is due to the presence of excess \( \text{OH}^- \) ions competing with dye anions for adsorption sites. As the pH of the system decreases number of negatively charged surface sites increases.

It was seen that the adsorption followed both Langmuir and Freundlich isotherms although considering the value of \( R \) Langmuir equation gave a better fit [158]. It symbolized monolayer and a favorable adsorption.

The results indicate that cow dung ash, mango stone ash and parthenium leaves ash could be employed as low-cost alternatives to commercial activated carbon in wastewater treatment for the removal of leather dyes.