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Colour removal studies on treatment of textile dyeing effluent by Chitosan modified Watermelon rind Composite (CWR)

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Abstract : In the recent years Agricultural wastes have been reported as potential and low-cost adsorbents.Agriculture waste undergoes biodegradation when it is in solution for several days, hence its usage is limited.Chitosan was studied as a potential bio sorbent due to its positive charge and relatively low cost.Watermelon rind agrowaste was modified with chitosan toenhance its efficiency and adsorption property. Research on the removal of dyes from the textile effluents has fascinated much interest in the last few years. Among the various methods available, adsorption is an effective method for the colour removal studies. Compared to conventional adsorbents, researchers are seeking alternatives.

Chitosan modified Watermelon rind was characterised by XRD, SEM and FT-IR.The aim of this work is to investigate the efficiency of the composite (CWR) in the removal of dyes present in textile effluent and to verify the effect of various physicochemical parameters such as effect of pH, adsorbent dose and the temperature on the colour removal process were studied.The colour removal was maximum at 0.2g adsorbent dosage and decreased on increasing and decreasing adsorbent dosage.

Key words: Chitosan, Watermelon rind, Composite, Colour,XRD.

Introduction

Common pollutants in textile effluents are dyes which are toxic, non- degradable due to their complex structure. As a result, the toxic effluents pose a huge risk to the environment if discharged untreated [1]. The discharged pollutant typifieschemical oxygen demand (COD), pH, total dissolved solids, biological oxygen demand and colour. Colour was a major difficulty to be considered, because a trace amount of dye in water creates serious destruction to the aesthetic nature of the environment [2].Extensively reported methods for colour removal are coagulation, ultra- filtration, chemical oxidation, electrochemical, adsorption and photo oxidation. Among the above mentioned methods adsorption process, was found to be inexpensive, efficient and economical to remove the colour of effluents [3].Commonly used adsorbents include zeolite, clay, polymers and natural agricultural material [4].Among the various adsorbents, natural agricultural material are abundantly available, low cost and eco-friendly [5].Hence, the researchers showed much attention in converting the natural agricultural materials into useful adsorbents.In the recent years, many agricultural wastes have been used as an adsorbent for colour removal studies which includes waste orange peel, banana pith, coir pith, barley husk,and tamarind fruit shell[5-9]. Though, many low cost adsorbents are reported, there was a growing need for the low cost adsorbent with high adsorption capacity.

Chitosan a cationic polymer from natural resources has received much interest of the researchers, due to its inexpensive,biodegradability, nontoxic and environment friendly[10].Chitosan was extensively studied as abioadsorbent for the removal of colour, because of its several inherent properties [11].

Recently, Watermelon rind (agricultural waste) has been used as a bio adsorbent for the removal of heavy metal ions [12]. However, to the best of our knowledge, there have been no reports on the use of watermelon rind for dye removal from textile effluents.

The present work throws a light on the preparation of Chitosan modified watermelon rindto enhance the adsorption property for the colour removal of textile effluents. Both chitosan and watermelon rind are low cost and hence chosen tostudy its potential application as colour removal on textile effluents with different parameters such as adsorbent dosage, pH, and temperature.

Experimental

Preparation of Chitosan modified Watermelon rind composite (CWR)

Watermelon rinds (WR) were cut into pieces and washed several times by doubledistilled water. After thorough washing, it was dried under sun light for 7 days to removemoisturecontent. Then the dried pieces were washed with hot water (70^oC) to remove any soluble matter present anddried in an oven at 85^oC for 48 h. The oven dried WR waspowdered using conventional mixer and sieved through 100mesh range. The sieved powder was stored in desiccators and used for composite preparation.

Analytical Grade chitosan was purchased from SR scientific. To modify chitosan,5g of chitosan was first dissolved in 250 mL acetic acid (2%) and 5 g of the watermelon rind powder was then added to the solution. The mixture was stirred for 30 min and dried at 70^oC for 12hrs. The obtained was stored for characterisation.

Characterisation

The obtained powder was characterized by powder X-ray diffraction method using Cu$K\alpha$radiation Bruker (D8 Advance) X-ray diffractometer. Morphological studies were carried out by Scanning Electron Microscopy (FEI Quanta FEG 200). UV-Vis spectra were recorded using JobinYvonFluorometer. FT-IR measurement was executed using KBr disc technique (FT-IR spectrometer- ThermoNicolateCompany Avatar 330).

Adsorption studies

The adsorption studies were carried out as batch tests in magnetic stirrer. In a batch test, 25ml mL of textile effluent was used and a known amount of CWR adsorbent was added and the resulting suspension was kept under constant stirring for predefined time. After stirring, the suspension was centrifuged and the supernatant was analyzed for the colourremoval.The initial parameters of the textile effluent are listed below (Table.1).

Table1.Parameters of the textile effluent

S.No	Parameters	Initial values
1	pH	8.54
2	TDS	1500mg/l
3	COD	455mg/l
4	Colour	Greenish Blue

Results and discussion

Synthesis of Chitosan modified watermelon rind composite

The powder X-ray diffraction pattern of the composite was shown in fig.1. Pure chitosan shows two peaks at around 10^o, 20^o and 50^o respectively [13].CWR composite showed only a broad peak at 21^o. The disappearance of peaks at 10° and 50° confirms the destruction of intermolecular and intramolecular hydrogen bonding leading to the successful modification of chitosan.

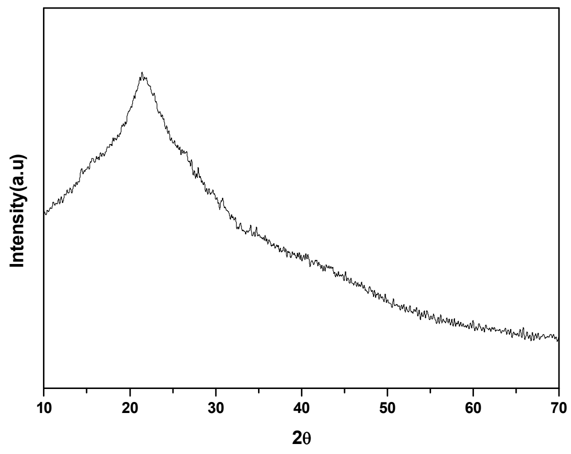

Fig.1.X-ray diffraction pattern of CWR (chitosan watermelon rind) composite

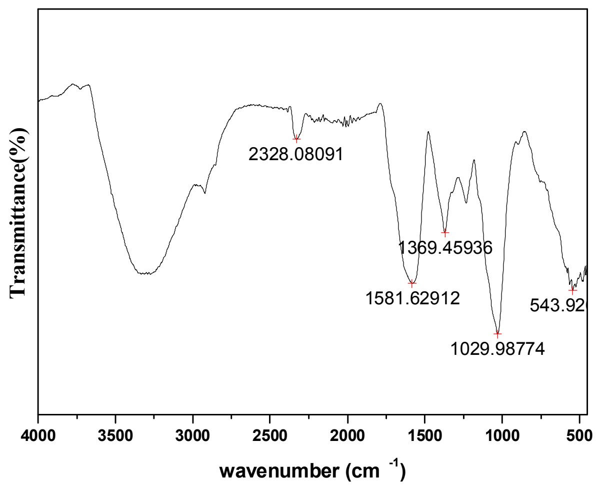

Fig.2.FT-IR spectrum of CWR (chitosan watermelon rind) composite

To understand the formation of chitosan modified watermelon rind composite, the powder was analysed by FTIR spectroscopy. The infrared spectrum was shown in fig.2.The spectrum of the obtained product was compared with the reported IR spectrum of pure chitosan [14](Table.1). From the Table .1 it is noted that characteristic vibrational mode at 3297 cm^{-1} is weakened after modification. The stretching vibration of NHCO group and bridge -O- group disappeared. In addition, N-H bending, amide and C-O stretching groups showed shift in the vibration peak. These observations prove the modification in the chitosan due to the interaction between amino and hydroxyl groupsof chitosan and watermelon rind.

Table 1 Comparison of FT-IR spectral details of chitosan and Chitosan modified Watermelon rind (CWR).

Peak assignment	Chitosan	Chitosan modified watermelon rind(CWR)
O-H stretch and N-H stretch, overlap	3428	3297
C-H stretch	2922 and 2860	--------
NH-CO (I) stretch	1653	--------
N-H bend	1598	1581
amide III	1381	1369
bridge-O- stretch	1154	--------
C-O stretch	1093	1029

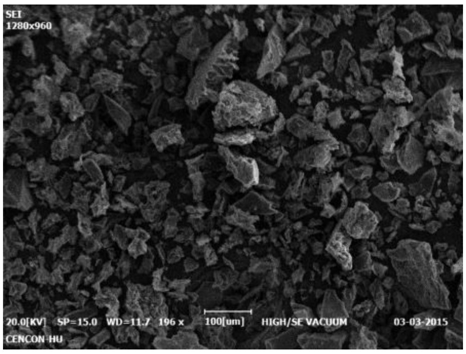

Fig.3. SEM image of Chitosan Watermelon rind (CWR)

The SEM micrograph of the CWRwas presented in the Fig. 3. Onanalysing the SEM image, one can observe the presenceof pores within the sample.The pore in the sample was used for the colour adsorption of textile effluent.

Adsorption Studies of CWR

Effect of pH, adsorbent and temperature

The percentage removal of colour was calculated by the following equation

% of Colour removal=$(C_0-C_i)/C_0$ x 100 %

where C_0 is the initial concentration of textile effluent and C_i is the final concentration of the textile effluent. The adsorption capacity of CWR composite was studied by varying the pH, temperature and adsorbent dosage for 25 ml of textile effluent. The effect of adsorbent dosage of CWR for the colour removal of textile effluent was investigated (30^0C, 8.54 pH / 2 hr) and the results are shown in Fig. 4. It was found that the colour removal increases from 0.01 to 0.2 g and maximum removal occurs at 0.2 g due to the increase in the adsorption site. From the graph it was observed that on further increasing the adsorbent dosage the efficiency of colour removal decreases. The decrease in the adsorption may be because of the unsaturation of the adsorption sites[14].Fig.5 shows the effect of pH on colour removal by CWR composite. pH plays a significant role in the percentage of colour removal. It was observed that the colour removal was maximum at lower pH because of the anionic charge of the CWR composite which facilitates the adsorption of colour cations [15]. The decrease in the percentage of colour removal on raising the pH to 10 is due to the increase in surfacecationic charge of the composite[]. It was observed that higher the temperature maximum colour removal efficiency was achieved from the fig.6. Thus the optimum dosage for the colour removal was 0.2g for 25ml of textile effluent.

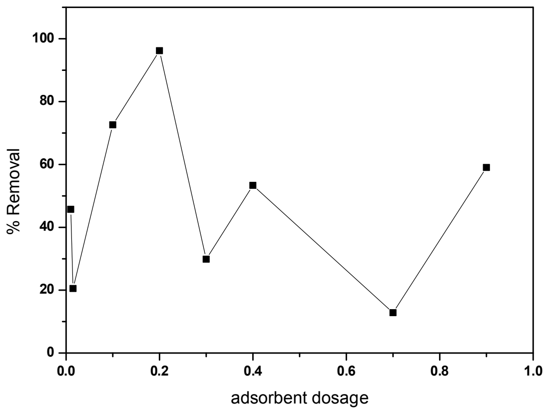

Fig.4.Effect of CWR dosage on colour removal of textile effluent

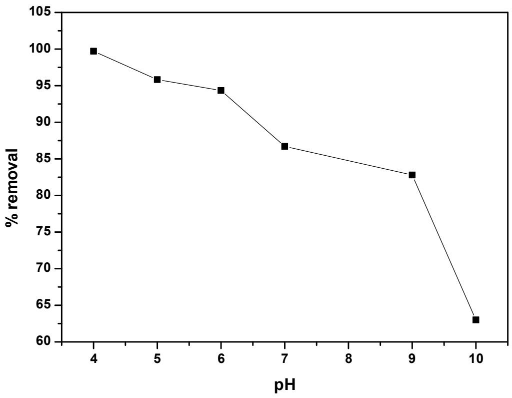

Fig.5.Effect of pH on colour removal of the textile effluent

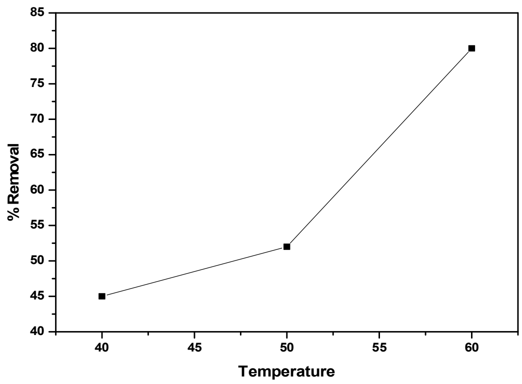

Fig.6. Effect of temperature on the percentage of colour removal of textile effluent

Conclusion

In this work chitosan modified watermelon rind composite was successfully prepared and applied as an adsorbent for the colour removal of textile effluent. Compared to other adsorbents CWR composite was low cost, can treat effectively and efficiently the textile effluent. Colour of the textile effluent was removed completely. The effects of various parameters such as pH, temperature and adsorbent dosage on adsorption were studied. The treated CWR composite was recyclable. So, this composite can be an alternative to high cost activated carbon and can be applied as an adsorbent for large scale treatment process in textile effluents for colour removal.

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