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Biosorption Tendency of *Cichorium intybus* for Roccelline NS in Aqueous Solution

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The present study was conducted to evaluate the *Cichorium intybus* as a biosorbent for the removal of roccelline NS from aqueous solution. *C. intybus* belongs to family *Asteraceae* is perennial herb and widely distributed through out Pakistan. Roccelline NS is an anionic dye, extensively used in textile industry in Pakistan and its removal from the aqueous solution is a serious problem. Different parameters such as pH, dye concentrations, biosorbent concentrations and particle size of biosorbent were studied on activated and unactivated biosorbent. Langmuir model was used to describe the biosorption phenomenon. It was concluded that activated biosorbent is most active for the removal of dye as compared to the inactivated. FTIR spectra showed that amino group adsorbed the dye thorough the electrostatic attraction between the positive charge of dye and negative charge of biosorbent.

Key Words: Bisorption, Anionic dye, Roccelline NS, *Cichorium intybus*.

INTRODUCTION

Synthetic dyes have wide industrial uses, such as rubber, textiles, plastics, paper and cosmetics *etc*., for the colouration of products. The effluents emanating from these industries are often coloured and require treatment prior to discharge. Several strategies currently exist for the removal of colour from industrial effluents, including physico-chemical and biological processes. Important physico-chemical processes include ozonation, adsorption, chemical precipitation and flocculation[1], but these are usually inefficient, costly and not adaptable to a wide range of dye wastewaters[2]. Conversely, biological processes, such as biodegradation, bioaccumulation and biosorption, offer attractive options for dye remediation[3, 4]. However, the use of biodegradation and bioaccumulation can be unpredictable, cumbersome and sometimes difficult to operate on a large scale, as stringent conditions (pH, temperature and nutrient concentrations) have to be maintained to support microbial growth[4]. In contrast, biosorption processes are relatively easy to operate and possess several inherent advantages, including low cost, operation over a wide range of conditions and the possible reuse of biosorbents[5]. Biosorption can be defined as the uptake of contaminants, *via* various physico-chemical mechanisms, including ion-exchange, adsorption, complexation, chelation and microprecipitation *etc*., by inactive/dead biological materials[5]. The mechanism of binding depends upon the type of biomass, chemical nature of the pollutant and the environmental conditions (pH, temperature and ionic strength). In this work, attempts were made to utilize the potential of the *Cichorium intybus*, as a biosorbent for the removal of roccelline NS from aqueous solution. The influences of pH and temperature were studied and the isotherms were described using several models.

EXPERIMENTAL

Preparation of biosorbent: The *Cichorium intybus* was obtained from local market was extensively washed with tap water to remove soil and dust. The dried powered biomass was washed with methanol and then with boiling water several times. The plant material was activated with HCl (6.0 N) and was stored in desiccator after washing with distilled water for experiments.

Preparation of anionic dye solutions: The dye stock solution of Roccelline NS was prepared of concentration 200 mg/L. The experimental solutions were obtained by diluting the dye stock solutions in accurate proportions to different initial concentrations.

Experimental methods and measurements: Biosorption experiments were carried out in a rotary shaker at 150 rpm and temperature was kept at 30 ºC using 250 mL shaking flasks containing 100 mL of different concentrations and initial pH values of dye solutions. The initial pH values of the solutions were previously adjusted with 0.1 M HNO_3 or NaOH. Different doses of sorbent were added to each flask and then the flasks were sealed to prevent change in volume of the solution during the experiments. After shaking the flasks for predetermined time intervals, the samples were taken out from the flasks and the dye solutions were separated from the sorbent by filtration with Whatmann filter paper No. 41. Dye concentrations in the supernatant solutions were estimated by measuring the adsorbance at maximum wavelengths of dyes with a Cecil-7200 double beam UV/VIS spectrophotometer and computing from the calibration curves. The amount of dyes sorbed by the biomass was calculated using the following equation:

$$q = (C_0 - Ce)V/W$$

Where q (mg/g) is the amount of dye sorbed by biomass, C_0 and Ce (mg/L) are the initial and equilibrium liquidphase concentrations of the dye, respectively, V (L), the initial volume of dye solution and W (g), the weight of the biomass.

Fourier transforms infrared analysis: The infrared spectra of the biosorbent samples in KBr discs were analyzed using a Fourier transform infrared spectrometer (MEDIAC-2000 series, USA), within the range 4000-400 cm^{-1}, to identify the functional groups responsible for the biosorption.

RESULTS AND DISCUSSION

Effect of initial pH: The pH of the solution can significantly influence the biosorption of dyes, the effects of pH on dye biosorption by the powdered *Cichorium intybus* was studied first. The value of pH used ranged from 2 to 12. The dye removal ratio was highest at the initial pH 2. The ratios of dyes sorbed decreased as the initial pH was increased from 2 to 5 and it kept constant beyond pH 5 (Fig. 1). For this reason, pH 2 was selected for all other experiments.

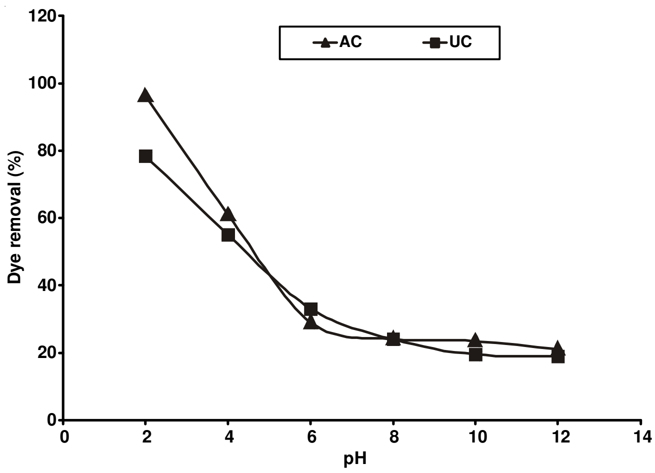

Fig. 1: Effect of pH on biosorption

Initial dye concentration: The effect of initial dye concentration on biosorption process was studied. As shown in Fig. 2, when the dye concentration was increased from 10 to 100 mg/L, the percentages of dyes sorbed decreased from 97.1 to 60.04 % and 87.3 to 48.2 % for activated (**AC**) and unactivated (**UC**) respectively. The Langmuir equation was employed to study the sorption isotherms of dyes.

The Langmuir equation is shown as follows:

$$Ce/qe = 1/(aQm)+Ce/Qm$$

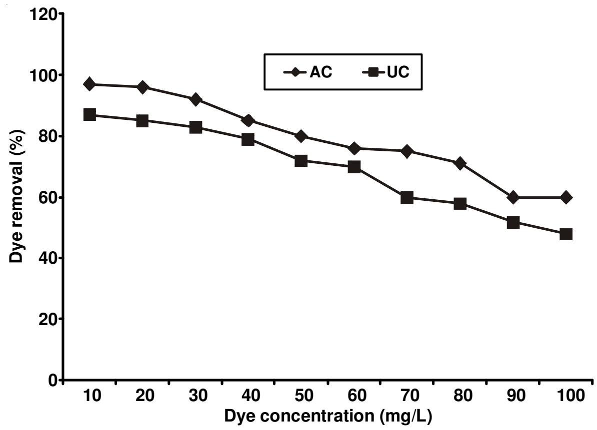

Fig. 2: Dye concentration.

where Ce (mg/L) is the concentration of the dye solution at equilibrium, qe (mg/g) is the amount of dye sorbed at equilibrium, Qm is the maximum sorption capacity and a is the Langmuir constant. The Qm (69.3 mg/g) and a (0.012) values were calculated from the slopes (1/Qm) and intercepts (1/aQm) of linear plots of Ce/qe *versus* Ce.

Effect of sorbent dose: The effects of sorbent dose on the removal ratios of dyes are shown in Fig. 3. The percentages of dyes sorbed increased as the sorbent dose was increased over the range 1.0-10.0 g/L. The biosorption ratios of dyes increased from 36.4 to 98.1 and 29.7 to 89.3 % for AC and UC, respectively and increase in biosorption with the sorbent dose could be attributed to increased surface area and the availability of more sorption sites.

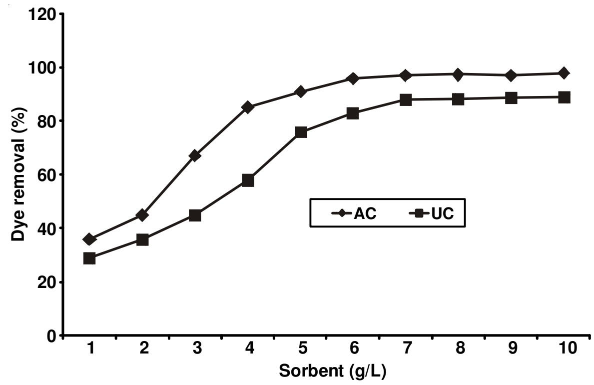

Fig. 3: Sorbent dosage

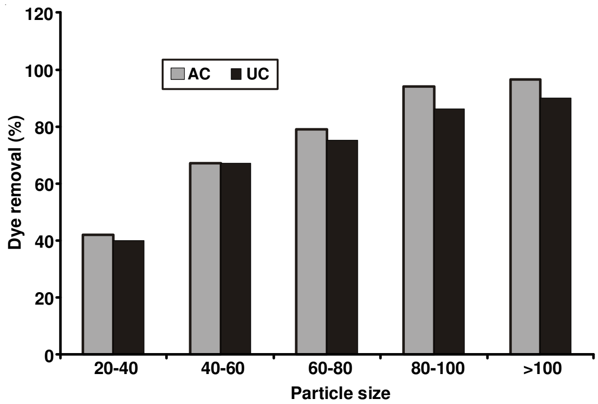

Fig. 4: Effect of particle size on biosorption

Influence of sorbent particle size: In order to check the effect of particle size of the biomass on removal of dye, different particle sizes of the biosorbents were used. The ratios of dyes sorbed increased as the sorbent particle size decreased, but the ratios of dyes sorbed had approached the maximum values in both activated and unactivated when the sorbent particle size is greater over 100 meshes.

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REFERENCES

1. Y.M. Sloka and A.M. Le Marechal, *Dyes Pigments,* **37,** 335 (1998).
2. I.M. Banat, P. Nigam, D. Singh and R. Marchant, *Bioresour. Technol.,* **58,** 217 (1996).
3. Y. Fu, and T. Viraraghavan, *Bioresour. Technol.*, **79,** 251 (2001).
4. Z. Aksu, *Process Biochem..* **40,** 997 (2005).
5. B. Volesky and S. Schiewer, in eds.: M. Flickinger and S.W. Drew, Biosorption of metals, Encyclopedia of bioprocess technology, New York, Wiley, pp. 433-453 (1999).