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Original article

Preparation of Biosorbent from Eucalyptus Trees and its Application for Removal of Some Pollutants in Water

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ABSTRACT

Background and aims. *Waste water largely possess organic and inorganic materials such as dyes. Over the years the use of dyes has increased and is immensely used in industries like in various kinds of the textile, paper, leather, food processing, cosmetics, rubber, printing and dye manufacturing industries. Even small quantities of dyes can color large water bodies, which not only affect aesthetic merit but also causes many significant problems such as increasing the toxicity and chemical oxygen demand of the effluent, and also reducing light penetration, which has a derogatory effect on photosynthetic phenomena. The objective of this study is to obtain anew natural biosorbent available in our environment and work to modify its physicochemical properties and that using by low cost- effective technique to enhance its adsorption capacity.* ***Methods.*** *Various parameters like initial dye concentration, PH, temperature and time of agitation were studied. The kinetic and thermodynamic of the crystal violet (Cr.V) sorption onto Eucalyptus biosorbents was studied.* ***Results****. Eucalyptus biosorbents was successfully prepared by heating treatment. The plot yield perfect linear curves and the removal rates of Cr.V using eucalyptus biosorbent were increased with increasing Cr.V concentrations.* ***Conclusion.*** *The Eucalyptus biosorbents were found highly efficient for the removal of crystal violet dye at PH 6-7 from aqueous solution and wastewater.*

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INTRODUCTION

Water Pollution from various processing of producing industries contain various kinds of organic and harmful substances such as dyes. Dyes such as Crystal violet are composed of many functional groups that are stable and difficult to decompose because of their aromatic nature. In textile industry a major class of commercial dyes is crystal violet, which is used for different purpose, such as for dermatological agent, veterinary medicine, biological staining, additive in poultry feed to reduce spread of fungus, mold and intestinal parasites and fungus. It also extensively used in paper printing. and is widely used for paints, pharmaceuticals, leather, detergents, fertilizers, varnish. And is for making of black and blue inks in printer ink jet manufacturing industrials [1]. It is a mutagen and mitotic poison. And its presence in water will cause a serious risk to aquatic life and constitute a potential human health hazard. It causes various eyes related like irritation, conjunctive and cornea injury. In severe cases, it can cause respiratory and kidney failure, permanent blindness and cancer [2,3]. This day is a potential biohazard as it has been proved to be a mitotic poisoning agent. It is therefore essential to remove this toxic and carcinogenic day from water.
Most dye molecules contain benzene ring structure, and they are especially resistant to oxidation and biodegrade, which makes the treatment of dyes wastewater more difficult. Up to now, different methods were developed for the removal of dyes from wastewater. Conventional techniques commonly applied for the removal of dyes from wastewater include chemical [4]. physical and biological [5]. treatment processes. Biosorption technique is one of the most efficient methods used for the removed of contamination from wastewater [6,7]. The design and efficient operation of biosorption process has been found to be effective and cheap [8,9]. The first major challenge for the biosorption field was to select the most

promising types of biomass from an extremely large pool of readily available and inexpensive biomaterials. Biomass – derived adsorbents are generating a great deal of interest among environmental researchers in recent times [10-12]. utilization of biomass for adsorption of wastewater –based pollutants have been constantly explored due to significant advantages such as easy scale-up, cost- effectiveness and environmental- friendliness [13]. The ability to covert biomass into water filtration systems will have potential implications in sustainability and the global impact in resource-limited setting and in developing economies. Among several biomass-derived materials studied, the sticks of Eucalyptus are abundantly available and economically available. The objective of this study is to obtain anew natural biosorbent available in our environment and work to modify its physicochemical properties and that using by low cost-effective technique to enhance its adsorption capacity.

METHODS

Preparation of Eucalyptus biosorbent by heat treatment

The raw biosorbent of Eucalyptus were obtained from a plantation in Janzur, Tripoli, Libya. The sticks of Eucalyptus tree were cut to small pieces, the sticks were soaked in distilled water for 1 day to remove impurities, then washed in (0.05M) NaOH, then washed in (0.05M) HCL, then washed by distilled water. Finally, the washed sticks were dried in an oven at (105, 160, 230 ºC) for 24h. to prepare sample-1, sample-2 and sample-3 then the dried sticks were blended in electric blender. The Eucalyptus powder was sieved to obtain biosorbent with homogenous known particle size.

Recommended procedures

The removal of Cr.V dye onto Eucalyptus biosorbents was tested using batch experiment. An accurate weight (0.1g) of Eucalyptus biosorbents powder, which was automatically shaken with 30 ml from different concentration of Cr.V dye ranging from o.1mg/ ml to 1.0 g/ml for 25 min at room temperature. The removal (%E) and the Eucalyptus biosorbent capacity (Q, mmol/g) were calculated from the following relationship:

$$\%E = ((C_0 - C_e)/C_0\ )\ / C0) \times 100 \qquad (1)$$

$$Q = ((C_0 - C_e))\ V / m \qquad (2)$$

Where C_0 is the initial Cr.V dye Concentration , C_e is the concentration of in Cr.V dye in solution at equilibrium, V is the volume (mL) of Cr.V dye solutions and m is the mass (g) of Eucalyptus biosorbents.

RESULT AND DISCUSSION

Effect of Cr.V dye concentration

The effect of Cr,v concentration was studied for different Cr.V concentrations at PH 7 to determine the sorption capacity Q and that by the plotting relation between the amount of adsorbed dye per unit mass of Eucalyptus sorbent (Q) against initial Cr.V concentration (mmol/L). The plot yield perfect linear curves and the removal rates of Cr.V using eucalyptus biosorbent were increased with increasing Cr.V concentrations.

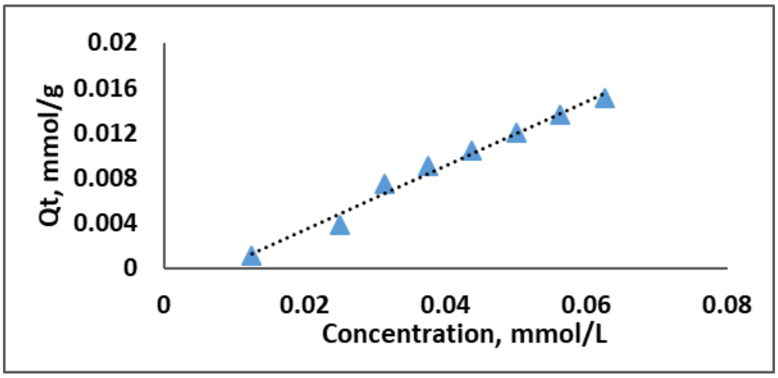

Figure 1. Effect of Cr.V dye concentration

Effect of PH

The optimum PH for the maximum sorption of Cr.V dye onto Eucalyptus biosorbents occurs at PH between 6-7, which give removal percentage between 84 to 98% for all samples.

Effect of shaking time for removal of Cr.V

The Effect of shaking time on Cr.V dye (100mg/L) removal using eucalyptus biosorbent at different time was studied, it noticed that the initial removal rate of dye is very rapid, were about 90 % of the total dye amount of Cr.V was removed at the first 1 minute. Then the rate becomes slower with the increase in time until reaching 100% at 42 minutes.

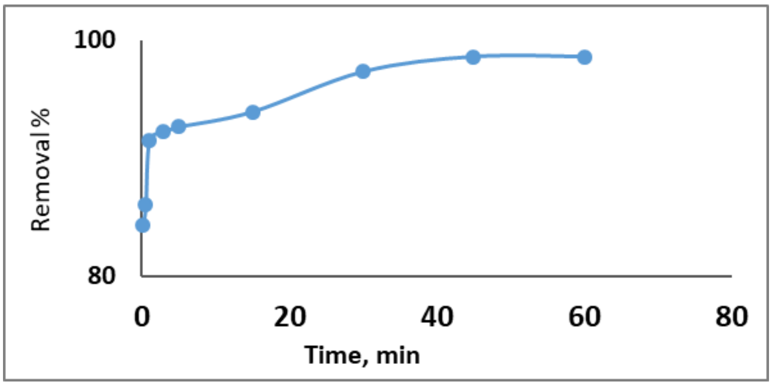

Figure 2. Effect of shaking time for removal of Cr.V

Temperature

The Effect of temperature (35- 80 ºC.) on the sorption of CV dye onto Eucalyptus biosorbents were studied. The removal dye percentages were plotted against temperature. The result obtained was slightly decrease with increase of temperature, the maximum removal of CV dye was observed at low temperature. Decrease of removal percentage is due to deformation of bonds between the dye molecule and the active site of eucalyptus biosorbents

Kinetic studies

The pseudo first order $\log(q_e - q_t) = \log q_e - (K_1 t/2.303)$ and pseudo second order of kinetic models $t/q_t = (1/K_2 {q_e}^2) + t/q_e$ are tested to investigate the mechanism of adsorption where q_e and q_t is the sorption capacity at equilibrium and at time t, K_1 and K_2 is the pseudo first rate constant and the pseudo second order constant. The half-life times [$t^{1/2}$] of pseudo first order are calculated by $t^{1/2} = 0.693/K_1$, and for second order calculated by $t^{1/2} = 1/q_e K_2$.The data showed that the average values of R^2 obtained for the pseudo- second order sorption model (0.997) are higher than that obtained for the pseudo- first order kinetic (0. 86), which indicates that the pseudo- second order sorption is predominant.

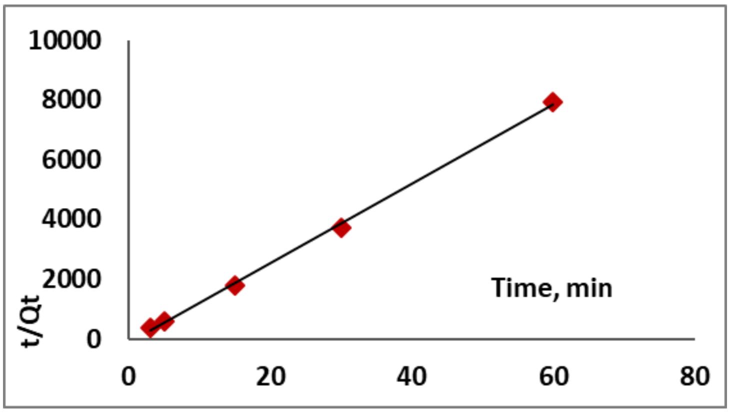

Figure 3. Pseudo second-order for removal of CV onto Eucalyptus biosorbents

The diffusion mechanism was investigated using the Morris-Weber, Reichenberg and Bangham equations.

$$Q_t = K_M \sqrt{t}$$

B = -0.4977- In (1-F)

$$\log\log(C_o / C_o - Q_{tm}) = \log(K_o m / 2.33V) + \alpha \log(t)$$

Where Q is the amount of Cr.V sorbed at time t. km is the intra particle diffusion rate constant (mmol/g min$^{1/2}$).The Bt. value is a mathematical function of $[F = Q_t / Q_e]$. Di is the effective diffusion coefficient, and α, k is constant.

Plots of Q_t versus $t_{1/2}$ for the diffusion of Cr.V onto eucalyptus biosorbent according to Morris-Weber Model give straight lines, were R^2 value is 0.84 which does not pass through the origin. The value of the diffusion rate constant is 0.0002 mmol/g min$^{1/2}$. The double logarithmic plots of the Bangham equation with the time yield linear curve. The correlation coefficient R^2 for the sorption of Cr.V onto the eucalyptus biosorbent is 0.68, this result shows that the diffusion of Cr.V onto pores of each sorbent is involved in the rate- controlling step. The value of α are 0.0009. For Reichenberg diffusion model, relation between and give correlation coefficient is 0,88 for removing of Cr.V using Lignin-biosorbent.

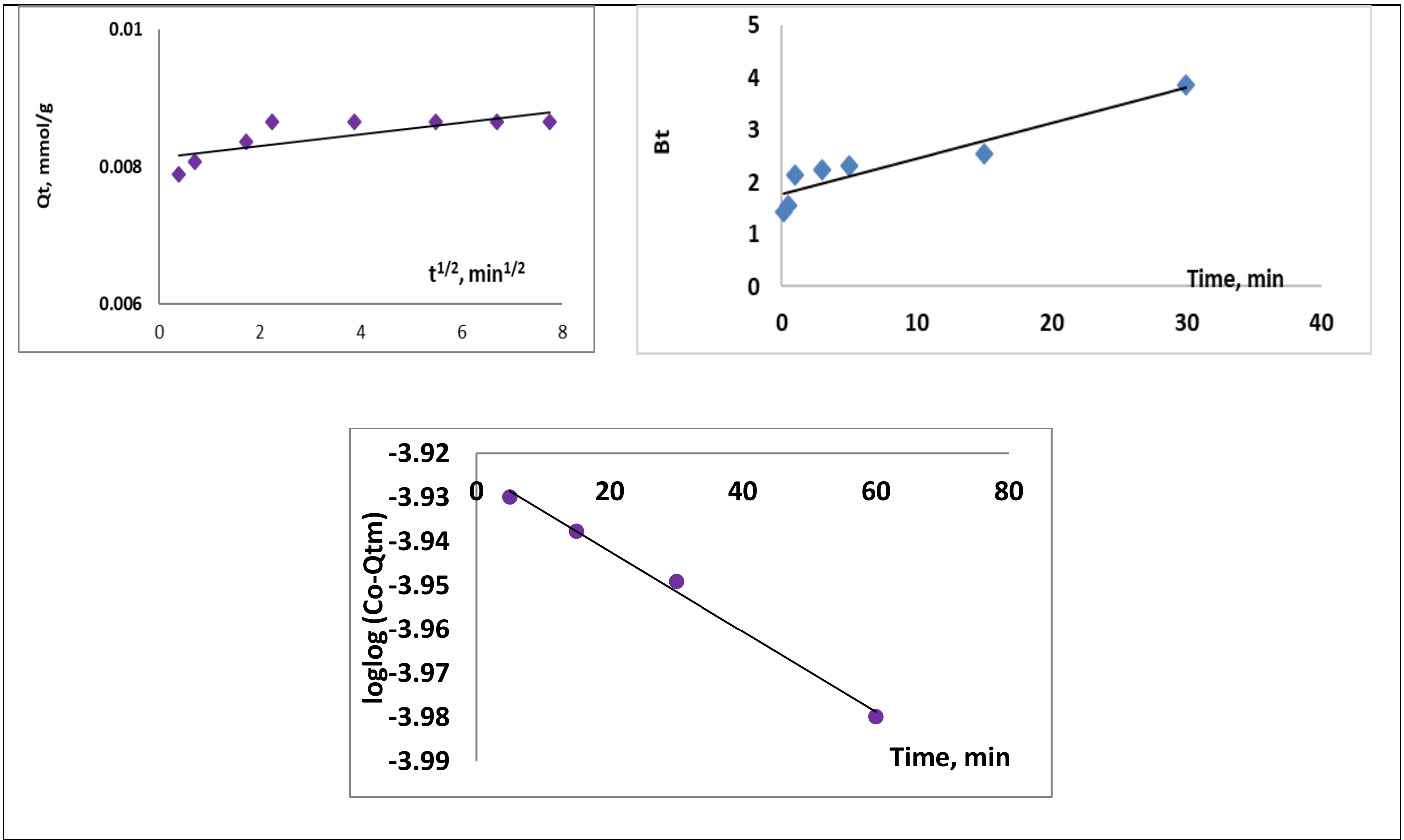

Figure 4. Diffusion models for sorption of Cr,V using Eucalyptus biosorbent

Thermodynamic studies

The thermodynamic parameters for the extraction process of Crystal violet dye onto eucalyptus biosorbents were estimated. The enthalpy (ΔH) was -30.5 J/K mol**,**The entropy (ΔS) was -29 J/K mol and the value of Gibbs free energy (ΔG) was -20 KJ

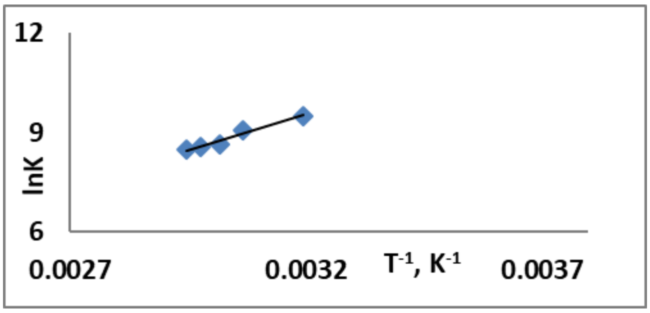

Figure 5. Thermodynamic for sorption CV using eucalyptus

Equilibrium studies

Langmuir [$C_e/Q_c = (1/K_L b) + (C_e/K_L)$] and Freundlich [$Log\, Q_c = Log\, K_F + 1/n\ Log\, C_e$] models are mainly used to describe sorption equilibrium of Cr.V using eucalyptus biosorbents. Langmuir isotherm is based on an assumption of monolayer sorption, independent energy of sorption and initially free sites. The freundlich equation assuming heterogeneous surface energy.

The average values of R^2 obtained from Langmuir model (0.94) is higher than that obtained from Freundlich model (0.68) indicated that the Langmuir model is a good fit to adsorption experimental data.

CONCLUSION

Eucalyptus biosorbents was successfully prepared by heating treatment (sample-1, sampl-2, sample-3). The kinetic and thermodynamic of Cr.V dye onto eucalyptus biosorbents was studied. The pseudo- second order kinetic model was found to be well suited for the entire adsorption process of Cr.V dye onto eucalyptus biosorbents. The thermodynamic parameter indicates that extraction of Crystal violet spontaneous process. The overall results indicated that the removal of Cr.V dye from aqueous solution and wastewater.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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