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COD and Color Removal from Textile Wastewater Using *Rosa damascena* Watering Waste Ash

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ABSTRACT

Aims Several methods have been used for textile wastewater treatment. The aim of this study was to evaluate the efficiency of *Rosa damascena* watering waste ash for COD and color removal from textile wastewater.

Materials & Methods Rose watering waste was gathered from one of the Kashan processing plants. The raw wastewater sample was taken from one of the textile industries in Kashan countryside. All experiments were run in the fixed volume (1L) of textile wastewater, contact times (15, 30, 45, 60, 75, and 90min), pHs (3, 5, 7, and 9) and different doses of rose watering waste (500, 1000, 2000, and 4000mg) at the room temperature (25°C). Moreover, biosorption kinetic studies for COD were done using the pseudo first and pseudo second order models.

Findings The amount of COD and color removal were increased by contact time increasing from 15 to 60min and the maximum removal of COD (50.3%) and color (31.4%) were seen at minute 60. Therefore, the contact time of 60min was chosen as the optimum contact time for the first step. The maximum amount of COD (51.9%) and color (32.9%) removal were seen at pH=5 and biosorbent dose of 2000mg. Changes at pH and biosorbent dose had significant effects ($p<0.05$) on amount of COD and color removal.

Conclusion The optimum condition for removing COD and color from textile wastewater is at contact time 60min, pH=5 and biosorbent dose of 2000mg. *Rosa damascena* watering waste ash was more effective on the COD removal than the color.

Keywords Color; Biological Oxygen Demand Analysis; Waste Water; Textile Industry

CITATION LINKS

[1] Removal of methylene blue by ... [2] Degradation and toxicity reduction of ... [3] Sequestration of dye from ... [4] Synthesis of magnetic β-cyclodextrin-chitosan/graphene oxide as ... [5] A novel and simple pathway to synthesis of porous polyurea absorbent and its tests on dye adsorption and ... [6] Adsorption/desorption of direct yellow 28 on apatitic phosphate: Mechanism, kinetic and thermodynamic ... [7] Removal of azo and anthraquinone reactive dyes from ... [8] Reactive Black dye adsorption/desorption onto ... [9] Kinetic and equilibrium studies of Cr (III) and Cr (VI) sorption from aqueous solution using Rosa gruss an teplitz (red rose) waste ... [10] Biosorption of reactive red 2 using ... [11] Removal of dyes from aqueous solution using fly ash and red ... [12] Activated hard shell of apricot stones: A ... [13] Utilization of agricultural waste corn cob for ... [14] The role of sawdust in ... [15] Copper ion removal by ... [16] Reduction of COD and color of dyeing effluent from a cotton textile mill by adsorption onto bamboo-based activated ... [17] Preliminary results on ... [18] Efficacy of modified distillation sludge of ... [19] Biosorption of Pb(II) and Co(II) on ... [20] Standard methods for ... [21] About the theory of ... [22] Pseudo-second order model for ... [23] Equilibrium, kinetic and ... [24] Biosorption of Reactive Black 5 dye by ... [25] Decolorization of Reactive Red ... [26] Treatment of pulp and ... [27] Biosorption of a reactive textile ... [28] Removal of Neutral Red from ... [29] Biosorption of textile metal-complexed ... [30] Removal of reactive ... [31] Removal efficiency of ... [32] Adsorption and kinetic studies of ... [33] Removal of Methylene Blue ... [34] Grass waste: a novel ... [35] Adsorption of reactive ... [36] Cationic and anionic dye ... [37] Reduction of COD in refinery wastewater ...

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Introduction

Textile dyeing industries consume lots of water in dyeing and finishing processes. Due to the aquatic environments pollution, dyes used in these industries should be considered. Dyes are composed of complex aromatic compounds which are resistant to biodegradation in aquatic environment [1, 2]. They are also detrimental for fauna and flora. Organic dyes have mutagenic and carcinogenic effects on human; they absorb sunlight and change the intensity of light absorbed via the phytoplankton and hydrophytes. As a result, photosynthetic and dissolved oxygen concentration and chemical oxygen demand (COD) level in aquatic environments increased [3, 4]. Therefore, dyeing wastewaters require to be treated before discharge to remove pigments [5]. Several studies have reported various methods for dye removal from water and wastewater such as combined chemical and biochemical processes, biological processes, membrane filtration, coagulation-flocculation, chemical oxidation, and adsorption [6, 7]. Adsorption, is one of the techniques that most employed for removing dyes due to its low cost, simplicity, potency in removing different types of dye and producing treated water with high quality [7-9].

This process is based on interaction between dye molecules and binding places on the adsorption surface. Recently, several researchers have focused on bioabsorption of dye among decolorization processes [10]. Agricultural wastes are recoverable and available in large amount as compared to other adsorbent material [3]. Industrial solid wastes utilization in wastewater treatment is economical. Also, it solves a disposal problem of solid waste [11]. Some of biological adsorbents for color and COD removal are apricot stone [12], corn cob [13], sawdust [14], almond shell [15], and bamboo [16].

Rosa centifolia and *Rosa damascena* are two main species of rose which are grown to produce rose oil. Rose oil production is done in countries such as Iran, Morocco, Turkey and Bulgaria.

To achieve the required products like rose oil and rose water, a large amount of rose flower is needed; as a result, rose waste is an issue [17, 18].

Researchers have used the various species of roses as an efficient biosorbent. For example, Nasir *et al.* investigated efficacy of modified distillation sludge of rose (*Rosa centifolia*) petals for lead (II) and zinc (II) removal from aqueous solutions [18]. Shafqat *et al.* used *Rosa gruss* to remove Cr (III) and Cr (VI) from aqueous solution [9]. Haq *et al.* studied biosorption of Pb (II) and Co (II) on *Rosa gruss* waste biomass [19]. Rose watering waste (*Rosa damascena*) has no commercial importance and its accumulation leads to environmental pollution.

In the present study, potential of *Rosa damascena* watering waste ash was examined for COD and color removal from real textile wastewater.

Materials & Methods

Rosa damascena watering waste was gathered from one of the processing plants of Kashan, Iran countryside. The waste was washed with deionized water to remove dirt particles. Then, it was dried in oven at 70°C for 48h. Next, it was soaked in 0.1N H_2SO_4 solutions for 1h and rinsed with deionized water until reaching neutral pH. It was soaked in 0.1N NAOH solutions for 1h and rinsed again. Later, it was put in a furnace at 550°C for 1h to ensure that all the organic matters removed. Finally, the resulting product was grinded and sieved in mill with mesh size 60 (0.25mm) to achieve homogeneous sizes particles.

The raw wastewater samples were taken from September to October 2013 from one of the textile industries in Kashan countryside and each sample were divided to 66 samples in fixed volume (1L) for experiments. The samples were maintained at temperature ≤4°C in the laboratory. All the experiments were performed under laboratory conditions and batch system.

COD of the textile wastewater was measured by 5220 C.; closed reflux, titrimetric method; the standard methods for examination of water and wastewater 21st edition [20]. Color intensity was also measured using 30nm wavelengths spectrophotometry instrument (USA; APEL, PD-303UV) by 2120 C.; spectrophotometric method; the standard methods for examination of water and wastewater 21st edition. A pH meter (Iran; Fanavari Tajhizat Sanjesh, pH262) was used to measure pH. The initial COD concentration, color intensity (dark brown) and pH in raw wastewater were 1840mg/L, 70% and 10.5, respectively. All experiments were run in the fixed volume (1L) of textile wastewater, contact times of 15, 30, 45, 60, 75, and 90min, pHs of 3, 5, 7, and 9 and different doses of rose watering waste (500, 1000, 2000, and 4000mg) at the room temperature (25°C). The pH was adjusted with 0.1N solutions of Sulphuric Acid and Sodium Hydroxide. All samples were agitated using a shaker at 240rpm (Iran; Pole Ideal Pars, HMS8805) and filtered through 0.45µm Whatman filter paper. All the used chemical reagents were analytical grade and were purchased from Merck Company, Germany.

Amount of color removal (percent) was calculated based on "Dye removal percent= $(I_1-I_2)/I_1\times 100$" equation in which I_1 is the light transmission intensity of raw wastewater and I_2 is the light transmission intensity of treated wastewater.

Experiments on biosorption of COD and color using rose watering waste ash were done in 2 steps. At first step, the influence of contact times (15-90min) was investigated on COD and color removal in fixed pH and biosorbent dose. At second step, the effects of pHs (3, 5, 7, and 9) and biosorbent doses (500, 1000, 2000, and 4000mg) were studied in a fixed volume of 1L. To describe the biosorption mechanism of COD the kinetic data were analyzed using the pseudo-first-order [21] and pseudo-second-order [22] models.

The data was analyzed by excel and SPSS 16 software using ANOVA test to compare between the effect of various pH and biosorbent dose on COD and color removal.

Findings

The amount of COD and color removal were increased by contact time increasing from 15 to 60min and the maximum removal of COD (50.3%) and color (31.4%) were seen at minute 60. Therefore, the contact time of 60min was chosen as the optimum contact time for the first step (Figure 1).

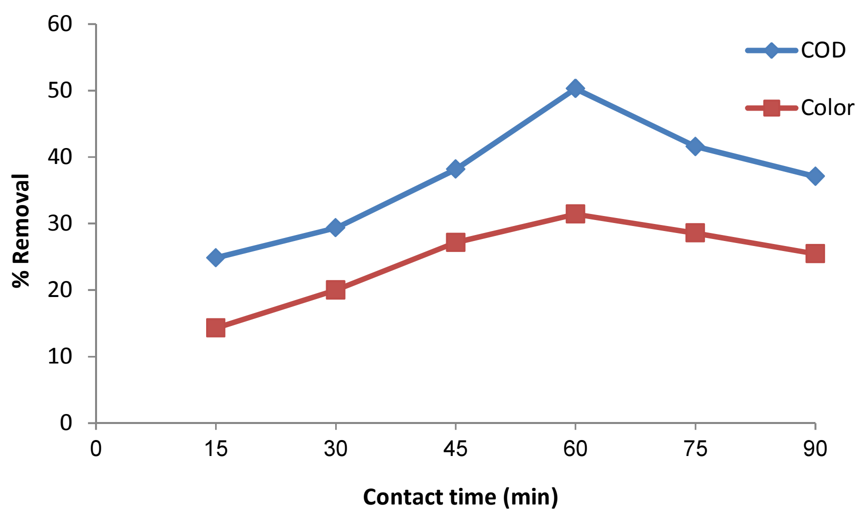

Figure1) Effect of contact time on COD and color removal

The maximum amount of COD (51.9%; Figure 2) and color (32.9%; Figure 3) removal were seen at pH=5 and biosorbent dose of 2000mg. Changes at pH and biosorbent dose had significant effects ($p<0.05$) on amount of COD and color removal.

The correlation coefficient (R^2) for the pseudo-first-order model was lower than for the pseudo-second-order model. Therefore, the kinetic data followed the pseudo-second-order model (R^2=0.911).

Discussion

The contact time is an important parameter to select the sorbent and its usage on real scale [23]. The biosorption capacity of COD and color was high at the beginning and it continued with the slower pace to reach an equilibrium

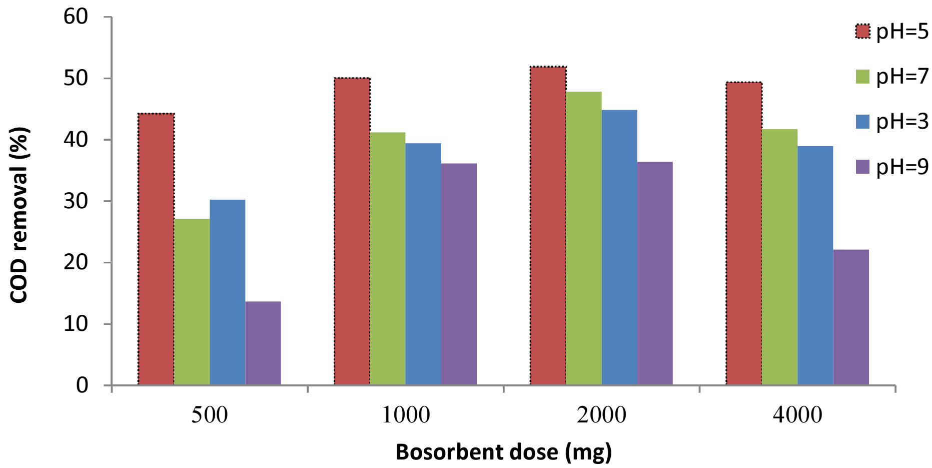

Figure 2) Effect of pH and dose of *Rosa damascena* watering waste ash on COD removal

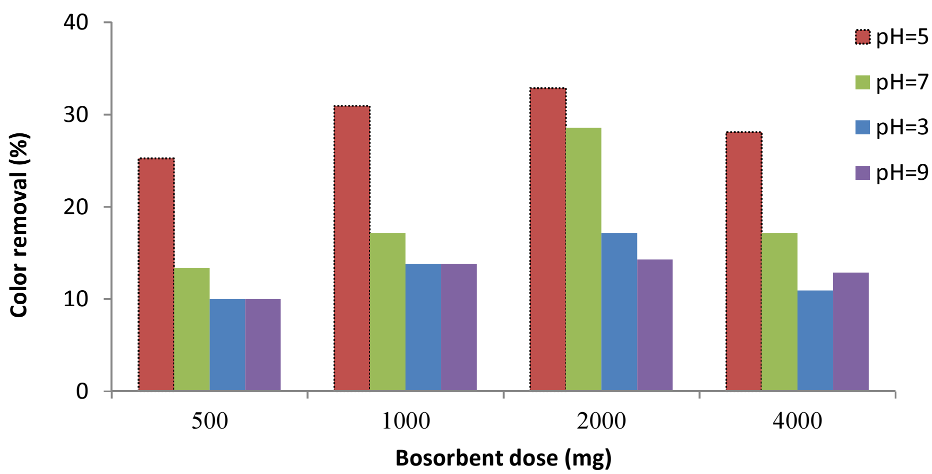

Figure 3) Effect of pH and dose of *Rosa damascena* watering waste ash on color removal

point. The maximum removal efficiency of COD and color occurred at 60min, so it was chosen as optimum contact time. High removal efficiency of pollutants at the first minutes is due to the availability of the large number of biosorption places on the biosorbent surface. Low removal efficiency of pollutants beyond the optimum contact time may be due to the repulsive forces between pollutants molecules on the biosorbent surface that cause desorption of molecules from the biosorbent surface [24].

Similar results of optimum contact time obtained by Bazrafshan *et al.* for decolorization of reactive red 198 by pistachio-nut shell ash [25] and Srivastava *et al.* for treatment of pulp and paper mill wastewaters with polyaluminium chloride and bagasse fly ash [26].

Previous studies have demonstrated the influence of pH on the biosorption process. It is said that pH affects surface binding places of biosorbents and ionization degree of the molecules [1, 27].

The maximum COD and color removal efficiency were obtained at pH=5. Lower efficiency at lower and higher pH can be due to the fact that at acidic pH (pH=3) biosorbent surface is surrounded by abundant hydronium ions, competing with cationic dyes for active biosorption places [28]. At alkaline pH is due to the abundance of OH^- ions, which compete with anionic dyes for biosorption places [29].

Same results of optimum pH were observed by Naddafi *et al* for removal of reactive blue 29 dye from water by single-wall carbon nanotubes [30], Mahvi and Heibati for removal efficiency of azo dyes from textile effluent using activated made from walnut wood [31], Madrakian *et al*. for adsorption of neutral red dye onto magnetite nanoparticles loaded tea waste and their removal from wastewater samples [32], rubin *et al.* for methylene blue removal from aqueous solutions using as biosorbent sargassum muticum [33].

COD and color removal efficiency increased with biosorbent dose increase, up to 2000mg. It is related to increase the accessible biosorption surface places. The reduction in removal efficiency at biosorbent dose (4000mg) can be due to overlapping of the biosorption places on the biosorbent surface or the splitting effect of concentration gradient between biosorbent dose and pollutant molecules which cause a reduction in the amount of pollutant biosorbed onto unit weight of biosorbent [24, 27, 34]. Same results of optimum biosorbent dose were reported by Asilian *et al.* for adsorption of reactive red 198 Azo dye from aqueous solution onto the waste coagulation sludge of the water treatment plants [35] and Srivastava *et al.* for treatment of pulp and paper mill wastewaters with polyaluminium chloride and bagasse fly ash [26].

The adsorption rate is one of the important factors to choose the adsorbent with the large adsorption capacity and fast adsorption rate [36]. Biosorption of COD onto *Rosa damascena* watering waste ash was evaluated with the pseudo-first-order and pseudo-second-order model and the pseudo-second-order model with higher correlation coefficient (R^2) was selected. Similar results has been observed by El-Naas *et al.* for COD reduction in refinery wastewater through adsorption on date-pit activated carbon and Srivastava *et al.* for treatment of pulp and paper mill wastewaters with polyaluminium chloride and bagasse fly ash [26, 37].

The limitations of this study were variations in quality of raw wastewater that affect the removal percentage of COD and color. It is suggested that the co-application of the biosorbent and other methods be studied to treat textile wastewater.

Conclusion

The optimum condition for removing COD and color from textile wastewater is at contact time 60min, pH=5 and biosorbent dose of 2000mg. *Rosa damascena* watering waste ash was more effective on the COD removal than the color.

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