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Biosorption of Safranin-O from Aqueous Solution by Nile Rose Plant *(Eichhornia crassipes)*

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Abstract:

In this work Aquatic plant (Nile rose) was used to study adsorption of industrial dye (safranin-O from aqueous solution within several operation conditions. The dried leaves of Nile rose plant were used as adsorbents safranin-O from aqueous solution after different activations such as wet and dry enhancements. The data show increasing in dye solution removal percentage for both activation methods of the adsorbent and also dye removal percentage that was obtained by using adsorbent without any treatment with the progress contact time. The dye removal percentages at equilibrium time 40 minutes were 88.7% at non-activation, 92.3% at thermal activation, and 98.3% at acidic activation. The samples adsorbents before and after adsorption which were scanned by using Fourier Transform Infrared (FTIR) Spectrometry. The scan data showed that the adsorbents contained hydroxyl group in there structure of adsorbents.

Keywords: Nile rose, dye removal, safranin-O dye, adsorption and Thermal, and acidic enhancement.

Introduction:

The methods that were used in the treatment of wastewater and textile dyes removal with the harmful pieces have got attention growth of the scientists at the last few years because these dyes have higher toxicity, and risky environmental influences (1). The adsorption is one of these typical practices which was a higher influence in the environmental bio protecting function, specifically if the adsorbent is produced from plants wastes (2). In the past studies, there are numerous wastes of plants that were employed as adsorbents material (because wastes of plants have developed capacity of adsorption, available, non-harmful, cheap materials), as try to reduce problems related to the pollution of environment which comes from industrial effluent (3).

The waste plants that were utilized as adsorbents are *husk of rice* to remove dye of Congo red (4), *Lemna of water* is used to decolorize dye of methylene blue (5), *Common red* to remove dye of Congo red (6), and the dye of methylene blue (7).

When use in the waste of plants to remove textile dyes, an exciting substitute toward protective of the environment by diminishing their unsafe influence on the ecosystem, and creating economic side (provide a profitable utilize of these wastes). The plant waste contains a high percentage organic material as cellulose structure form, and relatively low percentage form metals. As we know, the cellulose function groups in their structure similar carbonyl groups, which can act as the active sites in the removal processes by attraction together with function group of the contaminate in the aqueous phase (8).Recently many papers showed that the *Common red* was active adsorbent, especially if surface enhancement of the raw material, and to improve the adsorption capacity by several chemical or physical modification methods like cross-linking (5-6), the addition of ionic molecules (9), and the insertion of new functional groups (10-11) have been used. The dry modification method is physical handling include heating the raw material at special temperatures, depending on the structure of the adsorbent, and practical size. Acid activation in these process the adsorbent treated with inorganic acid such as hydrochloric acid, sulfuric acid, or phosphoric acid. Nile rose plant is considered the world worst invasive aquatic weed. This plant is wide spread in many countries, but it has narrow growth in Iraq. Nile rose plant causes water

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evaporation, abstraction of navigation, and finishing and blockage of irrigation and draingge system (12-16). This work will achieve a comparative study for both dry and wet modifications for the Nile rose plant powder as a bio sorption for removal safranin-O from aqueous solution.

Materials and Methods:

Preparation and activation of Adsorbent

The waste of the Nile herb plant was obtained from Husseinia River at the Karbala Province. Using eliminated contaminate by handled with excess water for one hour, then washed with distilled water. The material was dried at room temperature for five days. The obtained natural material was powdered in pulverized mill, and the powder washed with distilled water until the color washing solution become colorless, at last the powder was dried at room temperature for 24 hours. Five gm from powder was handled with 100ml 0.01M of hydrochloric acid for one hour with stirrer, and then powder was washed with excess amount of distilled water and dried at room temperature for 24 hours. The powder was used as wet activation experiments. Other 5gm from powder was treated at 100 ^{o}C for two hours, the powder was used as dry activation experments (17).

Preparation Adsorbate Solution

The stock solution (1000mg/L) of safranin-O dye (Chemical formula= $C_{20}H_{19}N_4CL$, formula weight=350.8g.mol^{-1} supplied by BHD Chemicals) was obtained by dissolving suitable weight of powder dye in distilled water. The other investigational solutions were got by dilutions to get the operational solution at wanted concentrations (6).

Adsorption study

The adsorption experiments achieved by, 0.05g of Nile herb from each treated and non-treated powder (none, acidic, and thermal treated) was weighted every single into 250ml conical flasks. And added 100ml from dye solution with 20mg/L were added to each conical flask. then stirred vigorously for 200 minutes. The fragments of the adsorbent were separated from the solution by using the centrifuge. The final absorbance of dye was measured for each sample spectrophometrically at the wavelength corresponding to maximum absorbance for safranin-O dye (λmax=518nm) using a spectrophotometer (UV/VIS-JENWAY, 1600, German).

FTIR Studies

The FTIR studies (under region 4000-500 cm^{-1}) for adsorbents (before and after adsorption) were achieved by a PerkinElmer Tensor 27 Fourier transform infrared spectrometer (Germany), the samples of dry Nile Herb powder was mixed thoroughly with KBr and then pressed in vacuum to homogeneous disc with a thickness of about 0.9 mm (18).

Results and Discussion:

Safranin-O dye was released from its aqueous solution by using aquatic of Nile herbs ecofriendly adsorbent which was studied along with the effect of the modification conditions physical (thermal) and chemical (acidic) on the release of dye percentage and comparing it with original adsorbents that were examined also with the same operation conditions contact time (10-80 min). The experiments were achieved with concentration of dye 20 mg/L at pH-6.0 dye solution, temperature was (22±2^{o}C) and adsorbent weight 5g/L. Initially the decolorization process was achieved with energetically as shown in Fig.1.

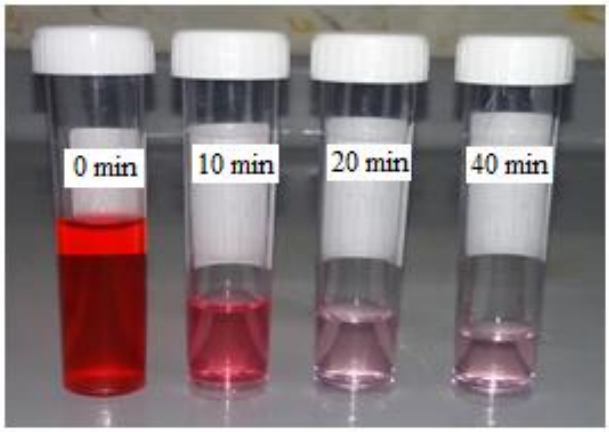

Figure 1. Gradually removal of 20ppm safranin-O dye on Nile Herb adsorbents at room temperature and pH 6.

Figure (1) explicates the color of dye solution disappears with contact time advancements, this observant instance agrees with the data in Fig.(2), which are obtained from absorbance measures at the same operation conditions, appears increasing in the removal of dye, for original and activated adsorbents with progress contact time.

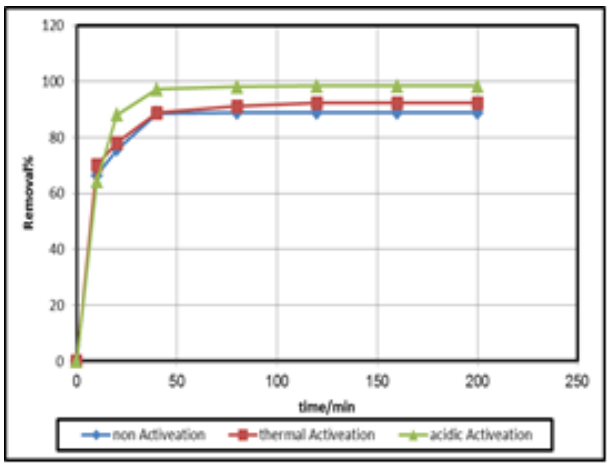

Figure 2. Adsorption of safranin-O dye on None, Acidic, and thermal activation of adsorbents.

From all of the adsorption dates that were obtained from adsorption experiments clarify the same behavior, such behavior as at the first 40 minutes there are strong and fast piratical dye adsorption on the adsorbent become of abounding active site, which saturation with passing contact time so the adsorption is reduced gradually until reach equilibrium station (5, 19, 20).

After comparing between enhancements adsorbents sample (physical and chemical absorbents enhancements), it has been found that the acidic activation was more active to removing sfaranin-o dye from then thermal activation, as is obvious in Fig. 3.

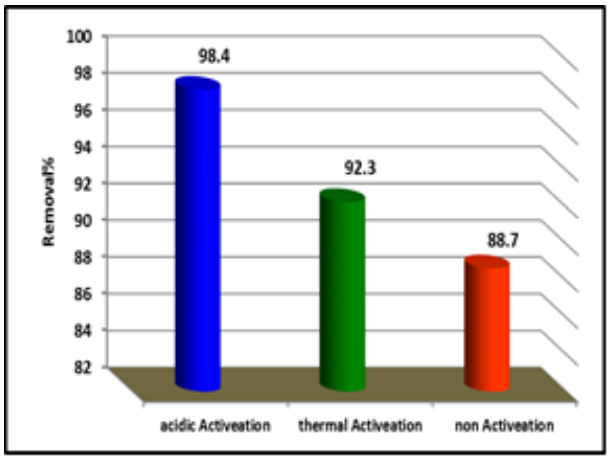

Figure 3. Adsorption of safranin-O on None, Acidic, and thermal activation of adsorbents.

From Fig. (3) the removal dye efficiency was 88.7% for non-activation, 92.3% for thermal activation, and 98.3% for acidic activation. The thermal activation includes dehydrating process, release the moisture, and impurities suspended on the adsorbent; this case increases the number of active sites due to surface area of the adsorbent (7, 23). The properties of the thermal enhancement comparing with the acidic activation, like increasing in the pour size, surface area. While in the chemical transformations happens because of acidic enhancement such as action exchanges. The thermal activation is favorable because of its being (i) cheap, (ii) the adsorbents decomposition is controlled by concentration of acid, temperature, time impregnation (21, 22).

FTIR Spectroscopic studies

To identify the types of the functional groups of aquatic of Nile herb powder which interacts with the dye molecules in the aqueous solution; the samples of adsorbents before and after adsorption were scanned by using Fourier Transform Infrared (FTIR) Spectrometry after the samples of adsorbents were prepared with KBr as pallet. The spectrum that obtained in Fig. (4) represent FTIR spectrum of Nile herb powder before adsorption, and Fig. (5) represent FTIR spectrum of Nile herb powder after adsorption. The spectra of Nile herb powder appears of many weak peaks. This may be due to nature structure of Nile herb powder which consists of the hemicelluloses fibers like waste of Alhagi maurorum (23).

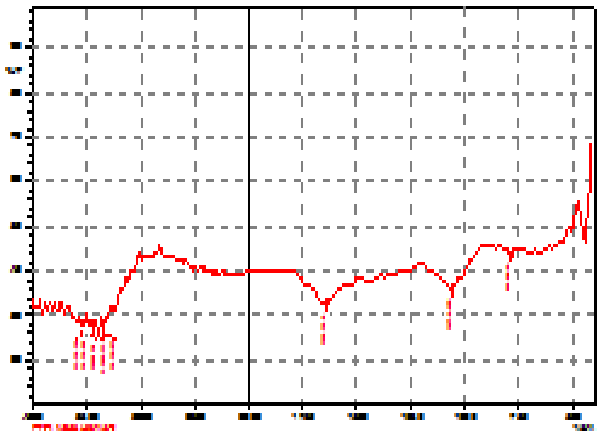

Figure 4. FTIR spectrum of Nile herb powder before adsorption.

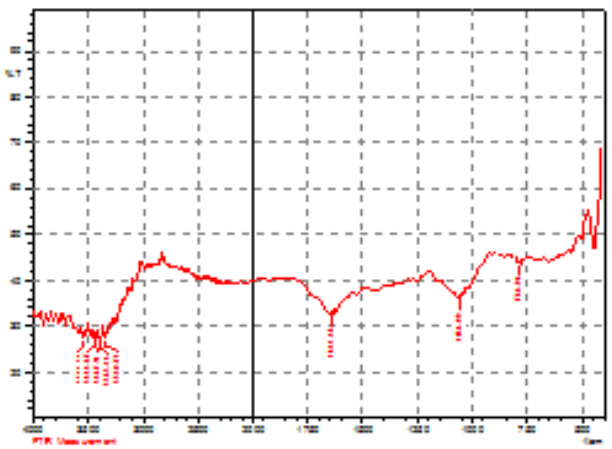

Figure 5. FTIR spectrum of Nile herb powder after adsorption.

The band at 3390.86 cm^{-1} position represents stretching vibrations of O-H alcoholic or phenolic in the structure of raw material, which appears at the position between 3300 and 3400 cm^{-1} (24). While the band at 1635.6 cm^{-1} refers to bending vibration of water, the fibers of hemicellulose have a strong affinity for water (25). Generally there are no changes in the peak position or peak area when comparing two spectra before and after adsorption. These results do not agree with that found in the other researches; may be the interaction between dye molecules and adsorbent particles was physical adsorption type (5, 6, 23).

Conclusion:

The effect of the acidic and dry activation on the removal dye has been investigated. From this study increasing dye removal for activated and non-activated adsorbents with progress contact time can be observed. The thermal treatment was less active than the acidic treatment for dye. The best operational complements were 20 gm/L the concentration of dye, 5 gm/L dosage of the adsorbent, pH 6 and contact time was 50 min.

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الامتصاص الحيوي لصبغة السفرانين من محلوله المائي بواسطة نبات زهرة النيل *(Eichhornia crassipes)*

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الخلاصة:

تم في هذا البحث استخدام مخلفات زهرة النيل لدراسة امتزاز الصبغة الصناعية (safranin-O) من محلولها تحت ظروف تجريبية معينة. استعملت الاوراق المجففة لزهرة النيل كمادة مازة لصبغة (safranin-O) من محلولها المائي بعد تنشيط مسحوق تلك الاوراق بطرق مختلفة مثل الطريقة الجافة والطريقة الرطبة. اظهرت النتائج التي تم الحصول عليها زيادة نسبة ازالة الصبغة من محلولها المائي بمرور الزمن ولكلا طريقتي التنشيط الرطبة والجافة للمادة المازة وكذلك نسبة ازالة الصبغة التي تم الحصول عليها باستخدام الماد المازة بدون أي تنشيط. حيث بلغت النسب المئوية لازالة الصبغة عند زمن التوازن الذي بلغ 40 دقيقة كالتالي: 88.7% للمادة المازة بدون تنشيط، 92.3% للتنشيط الحراري، 98.3% للتنشيط الحامضي. لقد تم اجراء مسح طيفي للمادة المازة قبل وبعد الامتزاز ضمن منطقة الاشعة تحت الحمراء FT-IR حيث اظهرت النتائج ان المادة المازة تحتوي في تركيبها على مجموعة الهيدروكسيل.

الكلمات المفتاحية: زهرة النيل، ازالة الصبغة، صبغة السفرانين، الامتزاز، التنشيط الحراري والحامضي.