

## Removing disperse orange 30 dye from simulated wastewater with quince leaves bioadsorbent

D. Şakar<sup>1\*</sup>, H. K. Gürakin<sup>2</sup>

<sup>1</sup>*Yildiz Technical University, Chemistry Department, 34220, Esenler, Istanbul, Türkiye*

<sup>2</sup>*SETAŞ Kimya Sanayi A.Ş., Organized Türkiye Industrial Zone, Karaagac Mah. 9th Street No:3 59510 Kapaklı, Tekirdağ,*

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In this work, quince leaves, which are a natural adsorbent, were used in their pure form without any chemical treatment. The leaves were subjected sequentially to washing, air drying, and oven drying processes. After oven drying, the quince leaves were crushed into small pieces to increase their surface area. The prepared adsorbent was used to determine the optimum conditions for the adsorption of disperse orange 30 (DO-30) from simulated synthetic wastewater. Within this scope, parameters such as adsorbent dosage (0.8 g and 1 g), 10, 30, 60, 90, and 120 min as contact time, 25, 30, 40, 50, and 60 °C as adsorption temperature, and 50, 100, 150, 200, 250, 300 mg/L as initial dye concentrations were investigated. Based on the experimental data obtained, the adsorption behavior of DO-30 onto quince leaves was evaluated. Langmuir, Freundlich, and Temkin isotherm models were applied to analyze the adsorption equilibrium of DO-30 dye adsorbed on quince leave bioadsorbent, while the pseudo-first-order, pseudo-second-order, and intraparticle diffusion models were used to examine the adsorption kinetics.

**Keywords:** *Quince leaves; disperse orange 30 dye; dye removal yield; adsorption kinetics and isotherms*

### INTRODUCTION

In recent years, the use of biologically derived adsorbents has increased in line with environmentally friendly and sustainable approaches. Biosorbents obtained from natural materials have attracted attention due to eco-friendly dye removal from wastewater. Biosorbents are biological materials used to adsorb or absorb contaminants, such as microorganisms, trash formed from biomass, or industrial byproducts. Heavy metals, dyes, and medications are just a few of the pollutants they have been utilized to eliminate. These materials are inexpensive, renewable, biodegradable, and require little processing. Because of their abundance, inherent surface functionality, and efficiency in binding dye molecules, plant-based adsorbents in particular have been thoroughly researched. Biosorbents, owing to their chemical and porous structures, can be used without any modification. Plant waste and biomass-based adsorbents are considered as alternatives to activated carbon due to their low cost, renewability, and lack of environmental impact [1-3]. Literature shows that quince leaves, thanks to their phenolic structures and functional groups, are an effective bioadsorbent for the adsorption of dyes such as safranin [4].

This study's primary goal is to investigate quince leaves' adsorption capabilities for removing

Disperse orange 30 dye from artificial wastewater solutions. Adsorption experiments were conducted using dried quince leaves under different adsorbent dosages (0.8 g and 1 g), adsorption contact time, adsorption temperature, and initial dye concentrations. The effects of both adsorbent dosage on dye removal were analyzed. Furthermore, the suitability of the system for isotherm and kinetic models was evaluated based on the experimental data obtained, and inferences were made regarding the adsorption mechanism.

### EXPERIMENTAL

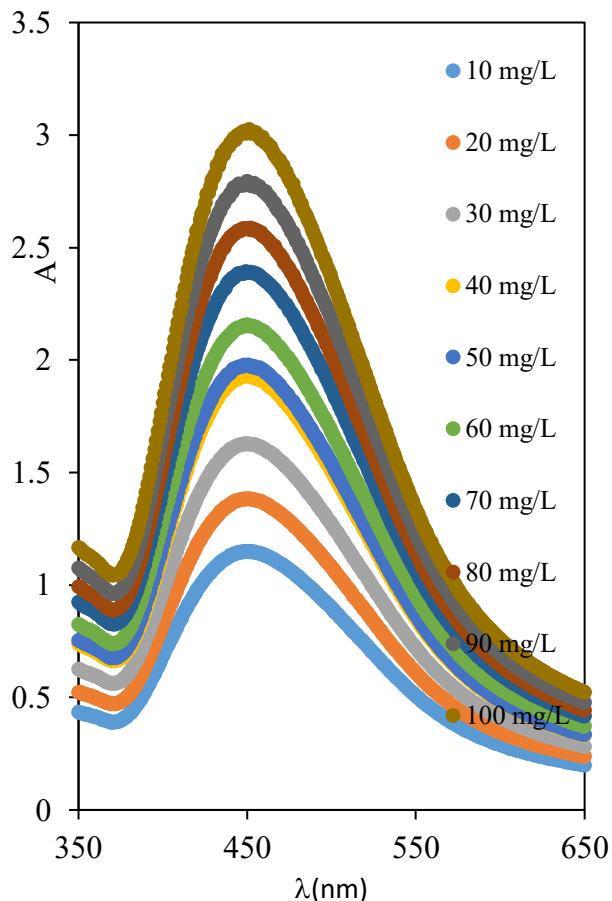
Quince leaves, used as adsorbents in the study, were washed, air-dried, and oven-dried to remove impurities. The leaves were ground into small pieces to increase their surface area. Figure 1 shows quince leaves, and ground quince leaves.



**Figure 1.** Quince leaves (a) and dried ground quince leaves (b)

\* To whom all correspondence should be sent:  
E-mail: dsakar@yildiz.edu.tr

Disperse orange 30 dye was supplied by SETAŞ. The used devices were Sigma trademark 3-18K model ultracentrifuge, Shimadzu UV/ VIS 2600 spectrophotometer and Daihan Scientific multi-heat mixer. The UV spectra of DO-30 dye solutions at different concentrations are given in Figure 2.



**Figure 2.** UV spectra of DO-30 dye solutions at different concentrations

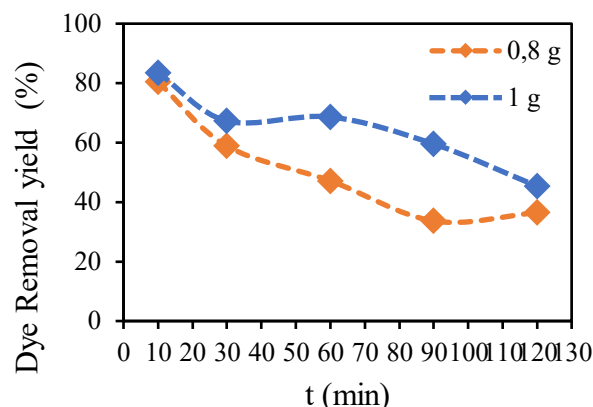
The DO-30 calibration curve equation was obtained as  $A=0.0201C+0.9979$  ( $R^2=0.9929$ ) according to Fig.2 at 450 nm absorbances.

## RESULTS AND DISCUSSION

The dried ground quince leaf bioadsorbents were used to eliminate the DO-30 dyestuff from artificial wastewater solutions via adsorption process. The parameters such as 10–30–60–90–120 min adsorption contact time in 100 mg/L DO-30 dye, 25–30–40–50–60 °C adsorption temperatures in 100 mg/L DO-30 dye, 50–100–150–200–250–300 mg/L initial dye concentrations, and 0.8 and 1 g adsorbent dosages were applied.

In contact time studies conducted using 0.8 and 1 grams of adsorbent, it was seen that the adsorption efficiency decreased as the contact time increased.

The graph of the relevant parameters is shown in Figure 3.



**Figure 3.** Contact time effect on dye removal yield for 0.8 g and 1 g adsorbent

As shown in Figure 3, increasing the adsorbent dose from 0.8 g to 1 g and increasing the contact time significantly reduced the dye removal efficiency from 10 min. to 30 min. This result suggests that the dye in the quince leaf transferred to the water over time.

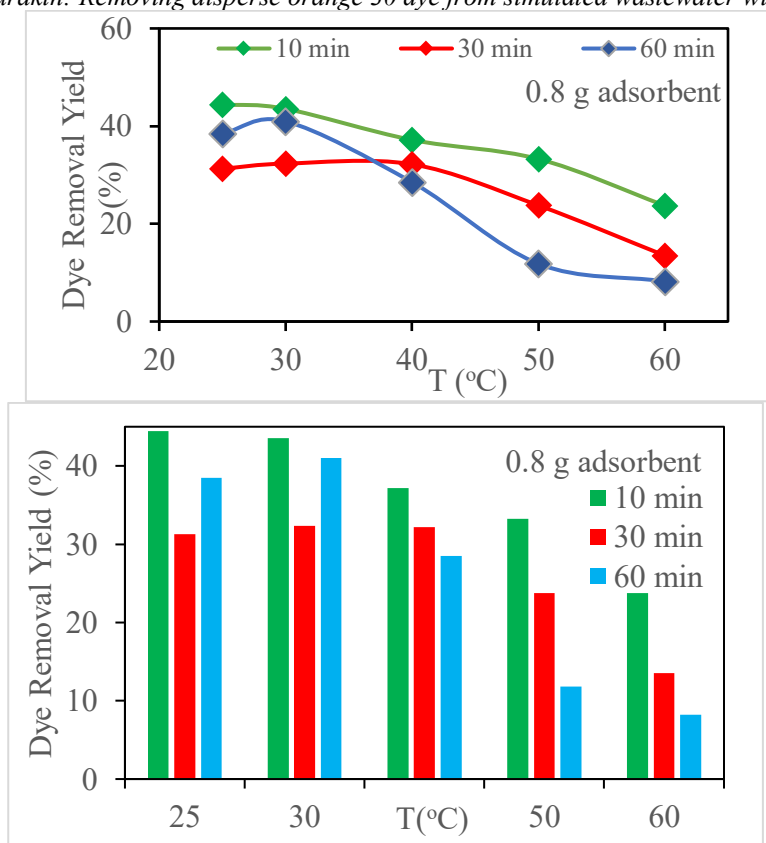
In temperature studies conducted between 25–60 °C, a decrease in adsorption efficiency was observed with increasing temperature. The temperature study performed with a dosage of 0.8 g of adsorbent is shown in Figure 4, and with 1 g - in Figure 5.

Langmuir [5], Freundlich [6], and Temkin [7] isotherm models were applied for 0.8 g and 1g of adsorbents at 10, 30 and 60 min.

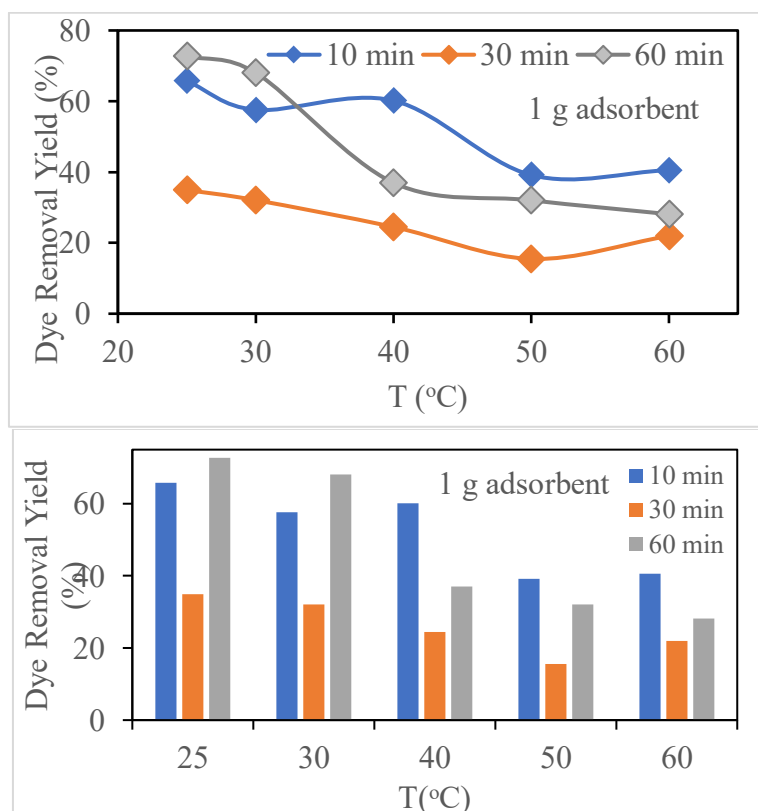
In studies conducted in the concentration range of 50–300 mg/L, removal efficiency decreased with increasing concentration. The best removal efficiencies for both adsorbent dosages were obtained at a concentration of 100 mg/L. Concentration studies for 0.8 g of adsorbent are shown in Figure 6 and concentration studies for 1 g of adsorbent are shown in Figure 7.

The highest regression coefficients were determined at the adsorption of 0.8 g and 1g of adsorbents at 30 min for Freundlich isotherm. (Figure 8).

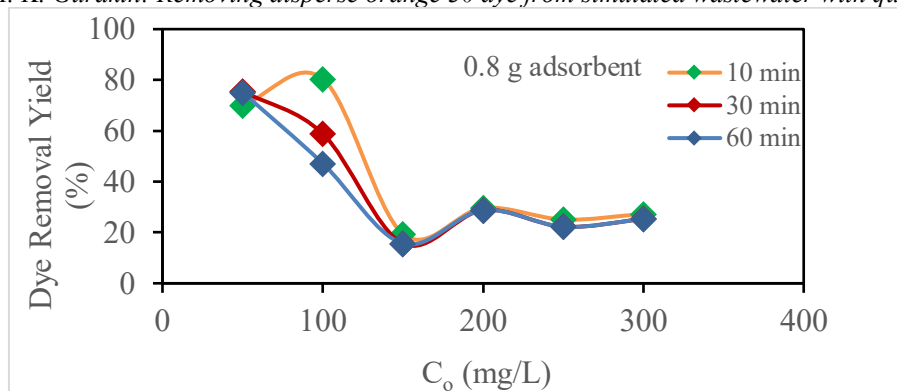
Pseudo-first-order, pseudo-second-order, and intraparticle diffusion models were used to determine the adsorption mechanism for 0.8 g and 1 g adsorbents for 100 mg/L DO-30 dye solution as 50 mL at 10, 30, 60, 90 and 120 min contact time. The highest correlation coefficient were obtained as the pseudo-second-order kinetic model (PSO KM) for 0.8 g and 1 g adsorbents as following in Figure 9.



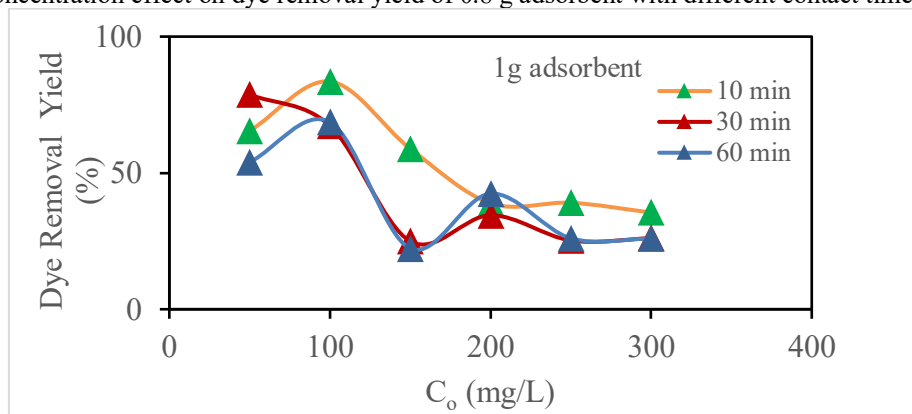
**Figure 4.** Temperature affect on dye removal yield for 0,8g adsorbent at 10 min, 30 min, 60 min



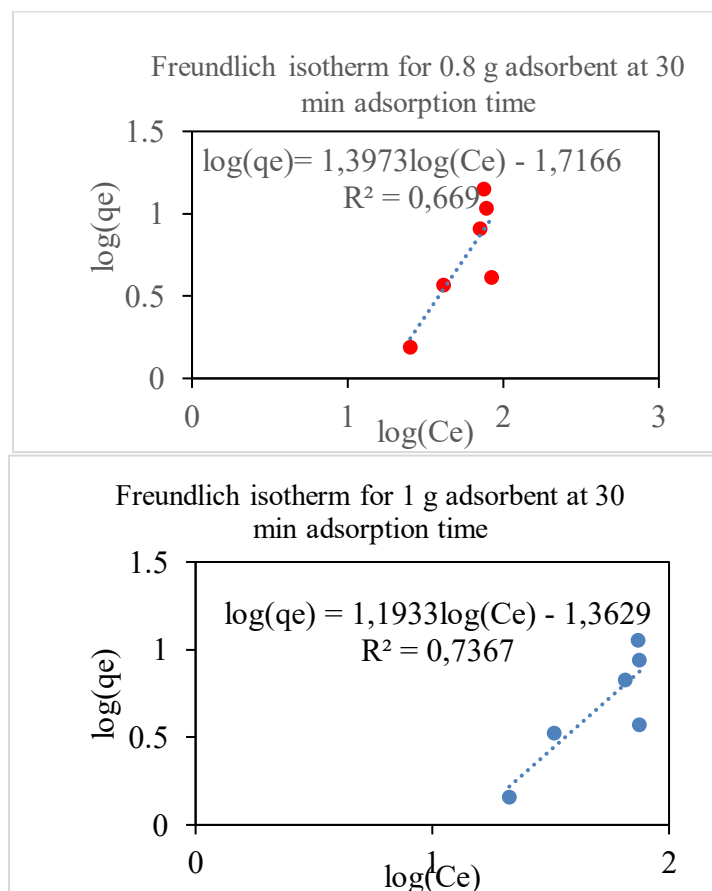
**Figure 5.** Temperature affect on dye removal yield for 1g adsorbent at 10 min, 30 min, 60 min



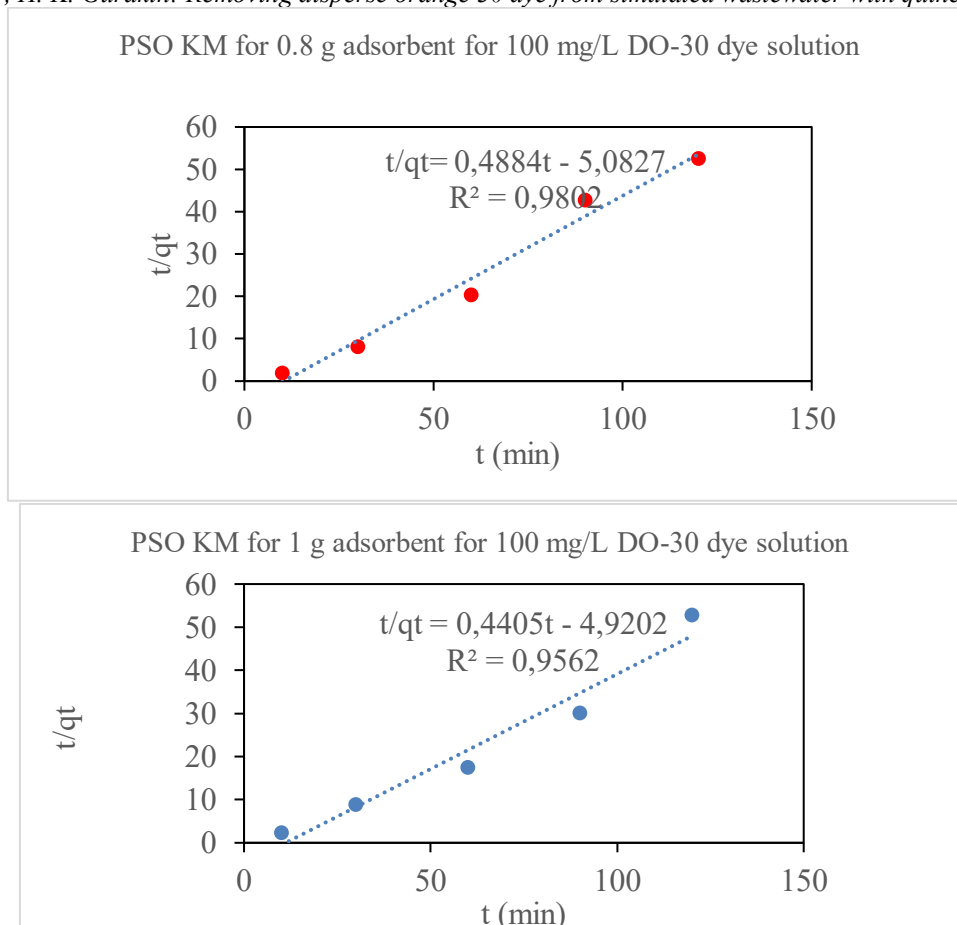
**Figure 6.** Concentration effect on dye removal yield of 0.8 g adsorbent with different contact time



**Figure 7.** Concentration effect on dye removal yield of 1 g adsorbent with different contact times



**Figure 8.** The Freundlich adsorption isotherms for 0.8 g and 1 g adsorbents at 30 min adsorption time



**Figure 9.** The Pseudo Second Order Kinetic Model for 0.8 g and 1 g adsorbents between 10 and 120 min adsorption time

## CONCLUSION

The results of this study revealed the potential of dried quince leaves without any treatment as an environmentally friendly and effective wastewater purification method and contributed to the removal of disperse orange 30 dye. It was found that increasing the contact time (from 10 min to 120 min) and temperature (from 25 to 60 °C) negatively affected the removal yield of DO-30 dye with quince leaves from synthetic wastewater (as 30 %).

The regression coefficient of the Freundlich isotherm was higher than the Langmuir and Temkin model. The kinetic studies proved that the adsorption of DO-30 dye on quince leaves bioadsorbent fits the PSO KM with good correlation.

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