ÇİLEK ATIĞI KULLANILARAK MAVİ BOYA GİDERİM ÇALIŞMALARI

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ÖZET
Yapılan çalışma çilek meyvesinin üzerindeki yeşil küçük yapraklar ile mavi boyaların giderilmesine yöneliktir. Yeşil küçük yapraklar sadece kurutularak ve aktif karbon haline getirilerek boya gideriminde denenmiştir. Bu şekilde, aynı maddeden iki farklı malzeme hazırlanarak giderim etkinliklerinin kıyaslanması amaçlanmıştır. Çilek yapraklarından hazırlanan bu iki malzeme ile giderim deneyleri mavi boyalar için yapılmıştır. Farklı yüklere sahip boyalardaki giderimin incelenmesi amacıyla, mavi boya olarak katyonik methylene blue ve anyonik reactive blue 49 boyaları seçilmiştir. Bütün deneysel parametreler sabitken katyonik ve anyonik karakterdeki mavi boyaların ham ve aktif karbon halindeki çilek yaprakları ile giderimi araştırılmıştır. Giderim deneyleri L mavi boya çözeltisi için 7.5 g madde ile, 25 mg/L mavi boya konsantrasyonları için 100 dakika boyunca sürdürülmüştür. Düzenli aralıklarla takip edilen deneylerde, 100 dakika sonunda ham çilek yaprakları % 53 ve aktif karbon çilek yaprakları % 99 katyonik mavi boya giderimi sağlamıştır. Anyonik mavi boya için ise 100 dakika sonunda ham hal ile giderilemezken aktif karbon ile % 24 giderime ulaşılmıştır. Diğer bir deyişle, ham çilek yaprakları % 53 katyonik boya giderimi sağlarken anyonik boya gideriminde başarılı olamamıştır. Aktif karbon çilek yaprakları ise % 99 katyonik boya giderimine ulaşırken anyonik boyayı % 24 gidermiştir. Çalışma sonucunda, seçilen mavi boyaya bağlı olarak çilek yapraklarının giderimlerinin farklılık gösterdiği gözlenmiştir. Malzemenin ham hali ya da aktif karbon hali de mavi boyanın gideriminde etkili rol oynamıştır. Ek olarak, methylene blue boyası için yüksek giderim başarabildiği de ortaya konmuştur.
Anahtar kelimeler: Anyonik boya, çilek, giderim, katyonik boya

BLUE DYE REMOVAL STUDIES USING STRAWBERRY WASTE

ABSTRACT
This study focused on the removal of blue dyes with small green leaves on strawberry fruit. The small green leaves were simply dried and processed into activated carbon to test dye removal. In this way, the aim was to compare the removal efficiencies of two different materials prepared from the same material. Removal experiments were conducted for blue dyes using these two materials prepared from strawberry leaves. To investigate the removal of dyes with different charges, cationic methylene blue and anionic reactive blue 49 were selected as blue dyes. The removal of cationic and anionic blue dyes using raw and activated carbon forms of strawberry leaves was investigated, keeping all experimental parameters constant. Removal experiments were conducted for 100 minutes with 7.5 g of L blue dye solution and 25 mg/L blue dye concentrations. In regularly monitored experiments, raw strawberry leaves achieved 53%, and activated carbon strawberry leaves provided 99% removal of cationic blue dye after 100 minutes. Anionic blue dye was not removed with the raw form, while 24% removal was achieved with activated carbon after 100 minutes. In other words, raw strawberry leaves provided 53% cationic dye removal but were not successful in anionic dye removal. Activated carbon for strawberry leaves achieved 99% cationic dye removal, while anionic dye was

removed at 24%. The study revealed that the removal rates of strawberry leaves varied depending on the blue dye selected. The raw material or activated carbon also played an effective role in blue dye removal. Additionally, high removal rates were demonstrated for methylene blue dye.
Keywords: Anionic dye, cationic dye, removal, strawberry

INTRODUCTION

With the rapid development of industrialization, increasing dye-related pollution in wastewater from the textile, printing, and dyeing industries has reached alarming levels (Lv et al., 2022). The materials selected for pollutant removal from polluted environments have a significant impact on the performance of the process (Abdollahi et al., 2025). Agricultural wastes, in particular, are used for pollutant removal due to their advantages such as ease of obtaining and low cost (Liu et al., 2026). In recent years, many studies have been presented on this subject (Abouzeid and El-Sayed, 2025; Bouchelkia et al., 2025; Mussa et al., 2025; Phal et al., 2025). Dyes and heavy metals are particularly common pollutants in wastewater (Ahmed and Ferdous, 2024). Methylene blue (MB), a cationic organic dye, must be removed from wastewater because it is hazardous to water due to its resistance to degradation (Liu et al., 2025). Reactive blue 49 (RB49), a reactive aminoanthraquinone dye, is generally preferred for printing cellulosic materials (Krupková et al., 2024).

This study aims to demonstrate the utility of strawberry leaves for dye removal. In addition to targeting dyes, two different dyes, cationic and anionic, were selected to understand the removal of different dye classes. Studies were conducted for the cationic methylene blue and anionic reactive blue 49 dyes to determine the removal behavior of dyes of the same colour but different characteristics. Thus, the study clarifies the effect of cationic/anionic character on blue dye removal. Removal studies for these dyes were repeated using raw (R) and activated carbon (AC) strawberry leaves under equivalent conditions. In this way, the effects of the materials on removal were also revealed.

RESEARCH

Two materials were prepared in the study:

1. The small green leaves on the strawberries were washed and allowed to dry. The dried leaves were ground.
2. The small green leaves of the strawberry were washed, dried, and ground. The materials were then subjected to the following processes, similar to and modified from previous studies: exposure to 200°C for 90 minutes, addition to a 3/4 ratio of potassium carbonate solution and holding for 2 days, and treatment at 700°C for 90 minutes (Gupta et al., 2022; Kılıç et al., 2012; Hayashi et al., 2002). They were then washed and dried.

The removal of cationic and anionic blue dyes was performed using the two prepared materials. Methylene blue was used as the cationic dye, and reactive blue 49 was used as the anionic dye. Changes in removal ratios were monitored for 100 min at a concentration of 25 mg/L, a leaf content of 7.5 g/L, a shaking speed of 190 rpm, and a temperature of 20 °C. Absorbance readings of the removals were taken using ultraviolet/visible region spectrophotometer. Absorbance readings were taken at 664 nm for the cationic dye and at 586 nm for the anionic dye. The obtained absorbance values were converted to concentration, percentage removal (%), and capacity (q) values to determine the progress of the removal process.

RESULTS

Within the scope of the study, anionic and cationic blue dye removal was studied with raw and activated carbon strawberry leaves. When the removals are evaluated based on the type of dye, the effectiveness of raw and activated carbon materials on a given dye could be determined. Figure 1 displays and allows for comparison of the removal percentage and capacity values of raw and activated carbon materials in the removal of cationic dye. According to Figure 1, cationic dye was removed by 53% with raw material and 99% with activated carbon.

Accordingly, activated carbon provided higher removal in cationic dye. Furthermore, the higher removal rate of cationic dye with activated carbon material is also noteworthy. The capacity exhibited for cationic dye removal was determined as 1.7 mg/g with raw material and 3.3 mg/g with activated carbon. Similar to the removal rate, activated carbon provided higher capacity for cationic dye.

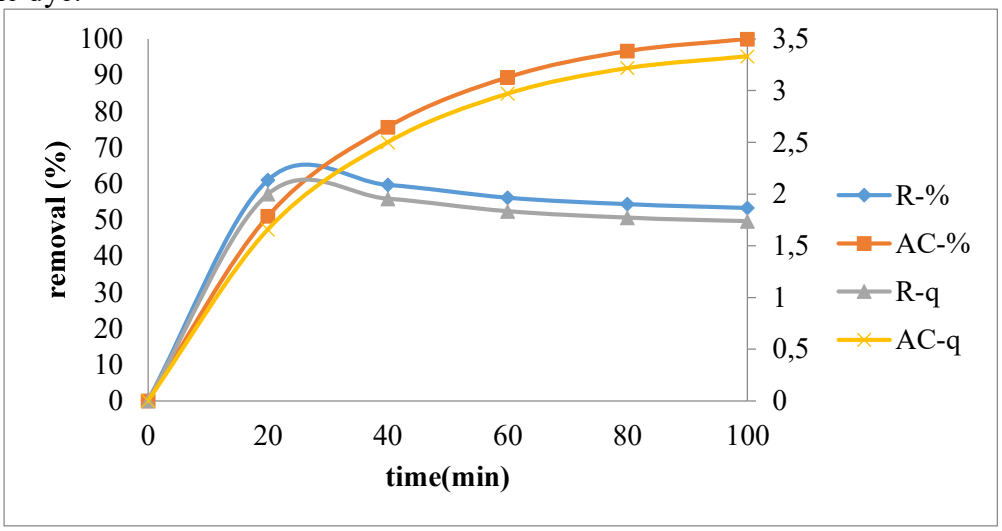

Figure 1. Cationic dye removal

Figure 2 shows the removal of anionic dye using raw and activated carbon strawberry leaves and is useful for comparing the removal rates and capacities for both materials. Figure 2 shows that raw leaves were ineffective, while activated carbon leaves were 24% effective in removing anionic dye. While activated carbon material provides some removal compared to its raw form for anionic dye removal, these results demonstrate that this rate is lower. Capacity values were also not obtained for raw leaves, but for activated carbon it was determined as 0.7 mg/g. Similar to the removal rate, the capacity value for activated carbon was also low for anionic dye.

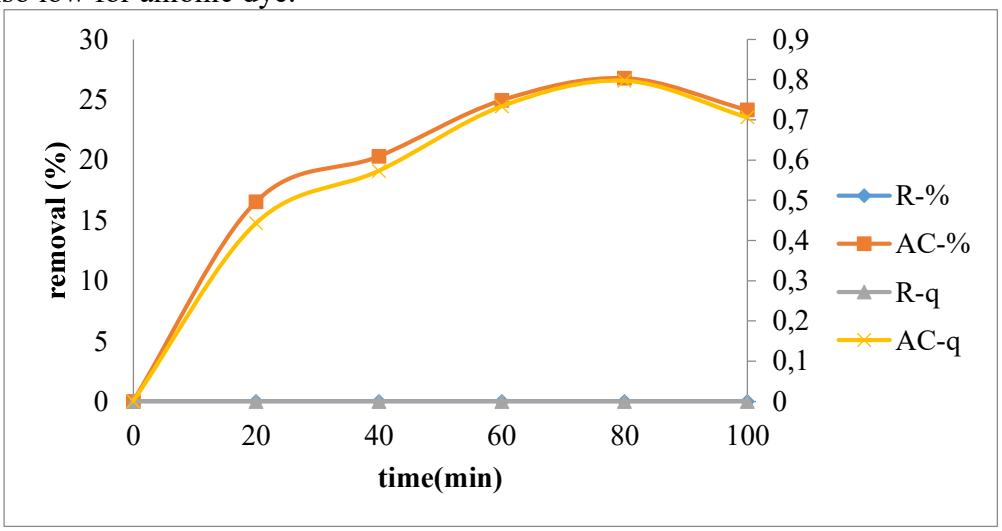

Figure 2. Anionic dye removal

The cationic and anionic dye removal efficiencies of the two prepared materials are also plotted. Figure 3 summarizes the effectiveness of raw strawberry leaves in removing the two dyes and shows them relative to each other. Figure 3 clearly demonstrates that the raw material is more effective at removing the cationic dye than the anionic dye. As given in the results above, raw strawberry leaves removed 53% of the cationic dye but failed to remove the anionic dye.

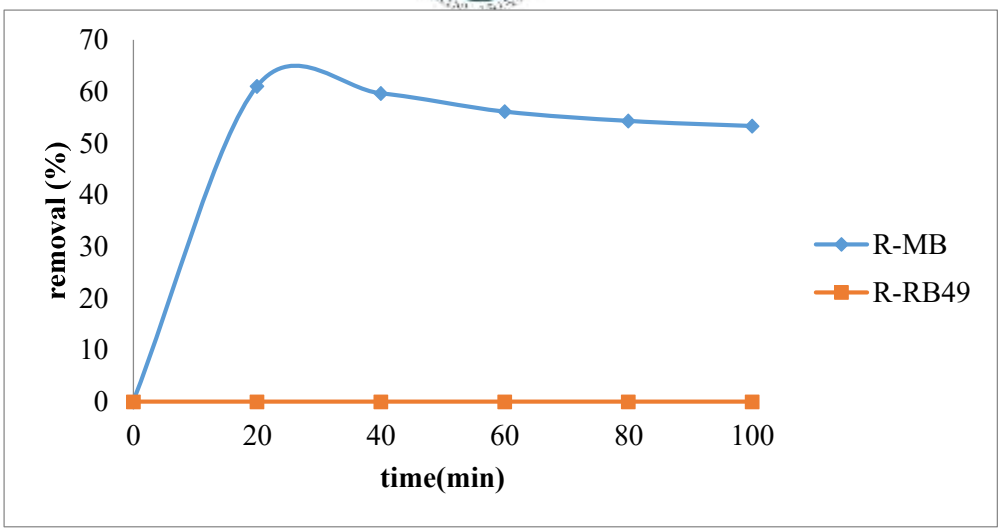

Figure 3. Removal efficiency of raw strawberry leaves

Figure 4 shows the removal of the specified dyes by activated carbon. Similar to the raw form in Figure 3, activated carbon from strawberry leaves exhibited better removal of cationic dye. The figure shows a 99% removal rate for cationic dye compared to 24% for anionic dye.

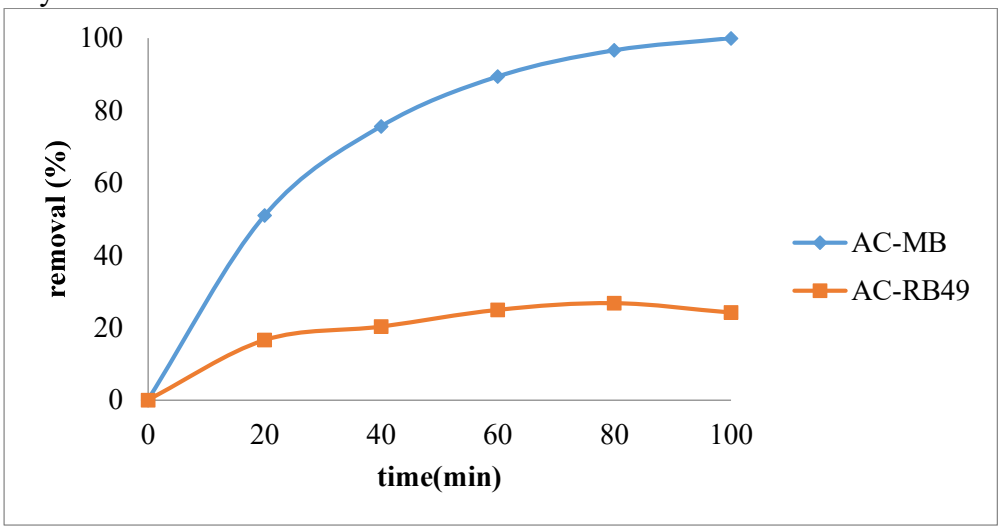

Figure 4. Removal efficiency of activated carbon strawberry leaves

CONCLUSION

In this study, small, unconsumable, waste strawberry leaves were used for dye removal in raw and activated carbon forms. The removal rates of two different materials prepared from strawberry leaves were investigated for dyes of the same colour but different characteristics (cationic or anionic). Thus, the removal of the blue cationic methylene blue and anionic reactive blue 49 dyes with these prepared materials was compared. As a result of the studies, when removal behaviour was compared by dye type, raw strawberry leaves achieved 53% efficiency, and activated carbon strawberry leaves achieved 99% efficiency in cationic blue dye removal. Additionally, the raw form was ineffective, while activated carbon was 24% effective for anionic blue dye removal. Accordingly, cationic dye were removed at higher rates with the materials. When the results were evaluated by material type, the raw material removed 53% cationic dye and 0% anionic dye. Activated carbon achieved 99% cationic and 24% anionic dye removal. Accordingly, activated carbon was more effective for the selected dyes than the raw form.

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