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PRELIMINARY EVALUATION OF ORANGE PEEL POWDER FOR THE REMOVAL OF SYNTHETIC DYES FROM AQUEOUS SOLUTIONS

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Introduction

Water pollution caused by synthetic dyes is an increasingly common issue due to their wide use in the textile, food, cosmetic, and pharmaceutical industries. These compounds are stable, resistant to natural degradation, and harmful to both aquatic ecosystems and human health, while conventional wastewater treatment methods are often costly and inefficient.

A significant source of dye pollution come from textile and food processing factories, highlighting the need for simple and eco-friendly solutions. Agricultural waste used as biosorbents represents a promising alternative, one of them can be orange peel that is abundant and rich in active functional groups that have strong potential for retained pollutants in adsorption process.

This study investigates the efficiency of powdered orange peel (OPP) in adsorbing four synthetic dyes, Brilliant Blue (BB), Sunset Yellow (SY), Congo Red (CR) and Methyl Orange (MO) from water, as a sustainable and low-cost method to reduce pollution.

Materials and methods

Methyl Orange dye (MO, purity > 95%), Briliant Blue dye (BB, purity > 97%), Congo red (CR, purity > 97%) and Sunset Yellow (SY, purity > 95%) were purchased from Sigma-Aldrich (Germany).

Stock solutions (1000 mg/L) of the selected dyes (analytical grade, Sigma-Aldrich) were prepared in ultrapure water. Subsequently the working solutions of 10 mg/L were obtained by diluting stock solutions and the dissolved organic carbon (DOC) concentration was determined (noted as t0 representing the initial concentration of dyes solutions that was not put in contact with OPP). For adsorption studies we used orange peel powder obtained in our laboratory ≈ 50 mg OPP was added into 100 mL Erlenmeyer flasks containing 20 mL of dye solution and stirred at 150 rpm at room temperature. For adsorption experiments two series were prepared: in the first, the suspensions were agitated for 4 h (t4h) and then filtered through cone-type filter paper, while for the second experiment the agitation was 24 h (t24h). After agitation,

the solutions were allowed to settle, and the supernatant solutions were analysed for dissolved organic carbon using a TOC-LCPN Shimadzu equipment.

Results and conclusions

Experiments with orange peel powder showed different adsorption results in function of contact time for the all dyes as is presented in Figure 1.

- Following the adsorption studies, it was observed that the MO is the dye less retained on the surface of OPP.
- Also, BB and CR show a rapid loss of DOC in the first 4h, adsorption attributed to physical interactions that are established between the structure of the adsorbent material and the structure of tested dyes.
- At the same time SY has a similar behaviour to BB and CR, but decreases even more sharply at 4h.
- Finally, at 24h, all solutions tend towards the same DOC level (~25 mgC/L), which suggests that, regardless of the nature of the dye, there is a common adsorption process.

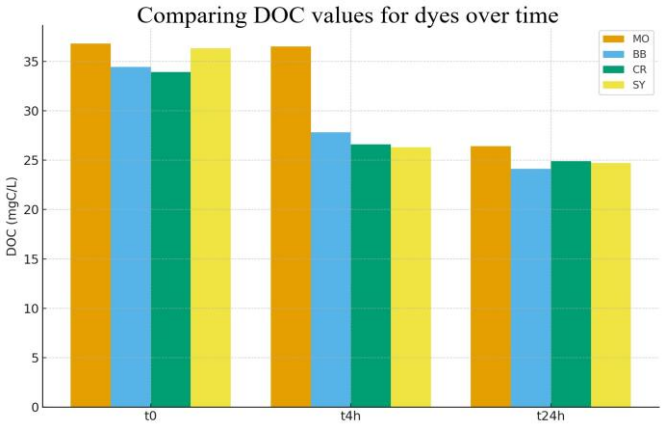

Figure 1. DOC amount (mg C/L) of synthetic dyes (MO, BB, CR, SY) using OPP over time. Experimental conditions used: 50 mg OPP, contact time (0, 4 and 24h) at 150 rpm at room temperature.

Although the removal efficiencies observed in this study are moderate, the simplicity of the preparation process, the use of waste biomass, and the encouraging initial results warrant further optimization. Future work will focus on the influence of pH, temperature, adsorbent dose, and contact time on adsorption performance, as well as testing with multi-dye systems and real wastewater samples. These findings contribute to the development of eco-friendly treatment strategies aligned with circular economy principles and are particularly relevant for small-scale or decentralized water treatment applications.