

Application of Raw Agro-Waste Materials in Methylene Blue Dye Adsorption from Wasterwater

Pedro Geraldo^{1,3} Isabel Pestana da Paixão Cansado^{1,2}¹MED—Mediterranean Institute for Agriculture, Environment and Development & Change – Global Change and Sustainability Institute, Polo da Mitra 7000-083 N^a Sr^a da Tourega, Évora, Portugal²University of Évora, Chemistry and Biochemistry Department, School of Sciences and Technology, Rua Romão Ramalho n^o 59, 7005-671 Évora, Portugal³University of Licungo, Avenida Julius Nverere, Campus de Coalane, Bloco II, n^o 1621, R/C, CP. 106, Mozambique

INTRODUCTION & AIM

The large-scale production of various synthetic dyes has contributed significantly to the discharge of large volumes of wastewater into the environment. It is estimated that annually, approximately 105 000 tons of dyes from the textile industry are released directly into the environment, significantly compromising water quality [1].

This study evaluates the adsorption potential of agricultural and timber residues (coconut shells, cork bark, almond shells, and olive pits) for the removal of methylene blue (MB) from aqueous solutions.

METHOD

All materials were used without prior thermal treatment. Kinetic experiments were conducted at 298 K, and pH 6. For that, 25 mg of adsorbent were added to an Erlenmeyer with 25.0 mL of MB solution (20 mg L⁻¹) and agitated at 20 rpm, up to 168 hours. Adsorption isotherms were obtained by adding 25.0 mg of adsorbent to 25.0 mL of MB solution (0–250 mg L⁻¹) and agitated at 20 rpm, for 24 hours. The influence of pH (3–11) was assessed by adjusting the pH of MB solution with 0.1 mol L⁻¹ HCl or NaOH, and following the previous procedure.

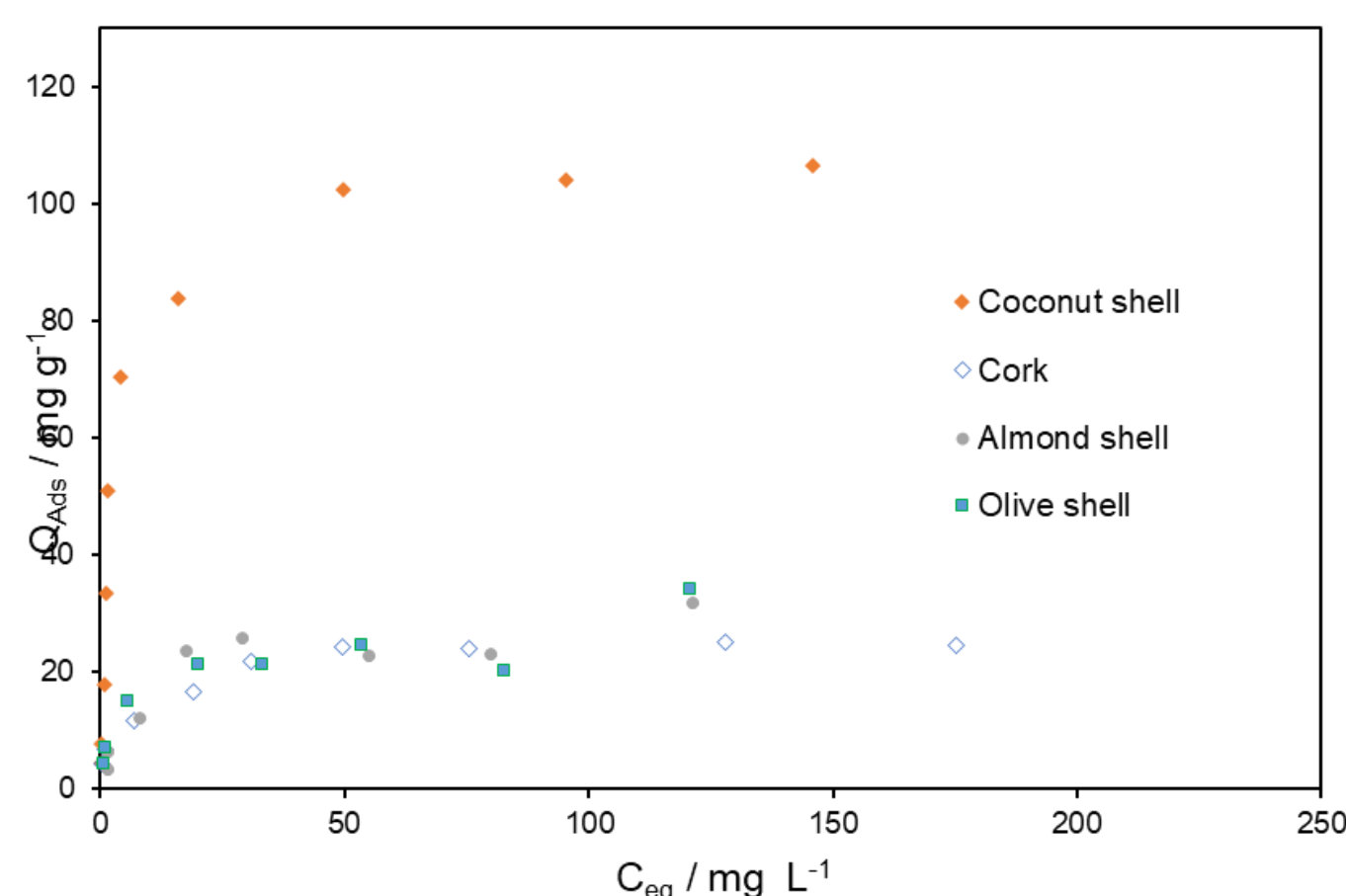


Figure 2 - Adsorption isotherms of MB on natural adsorbents.

RESULTS & DISCUSSION

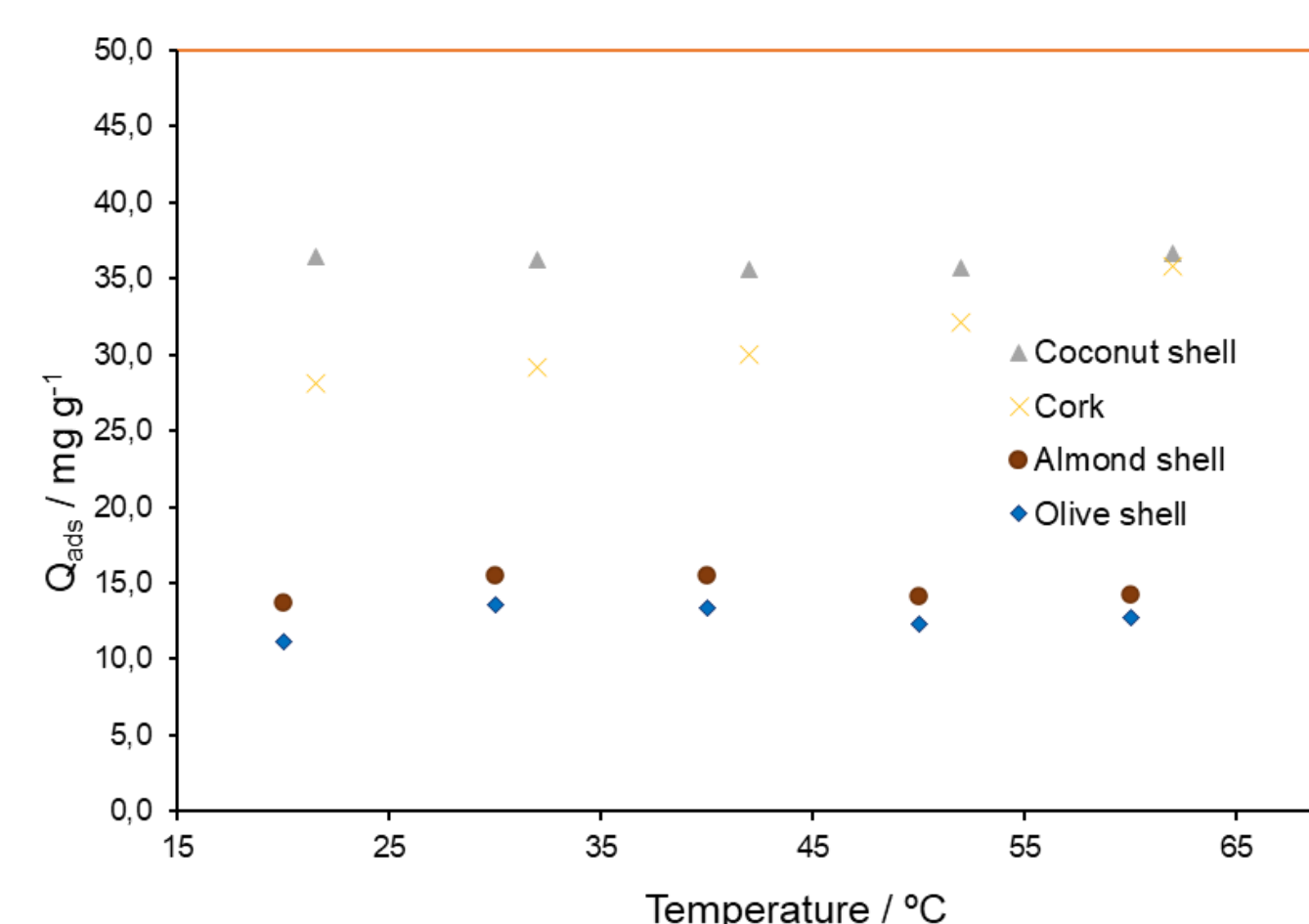


Figure 1 - Influence of temperature on MB removal using natural adsorbents.

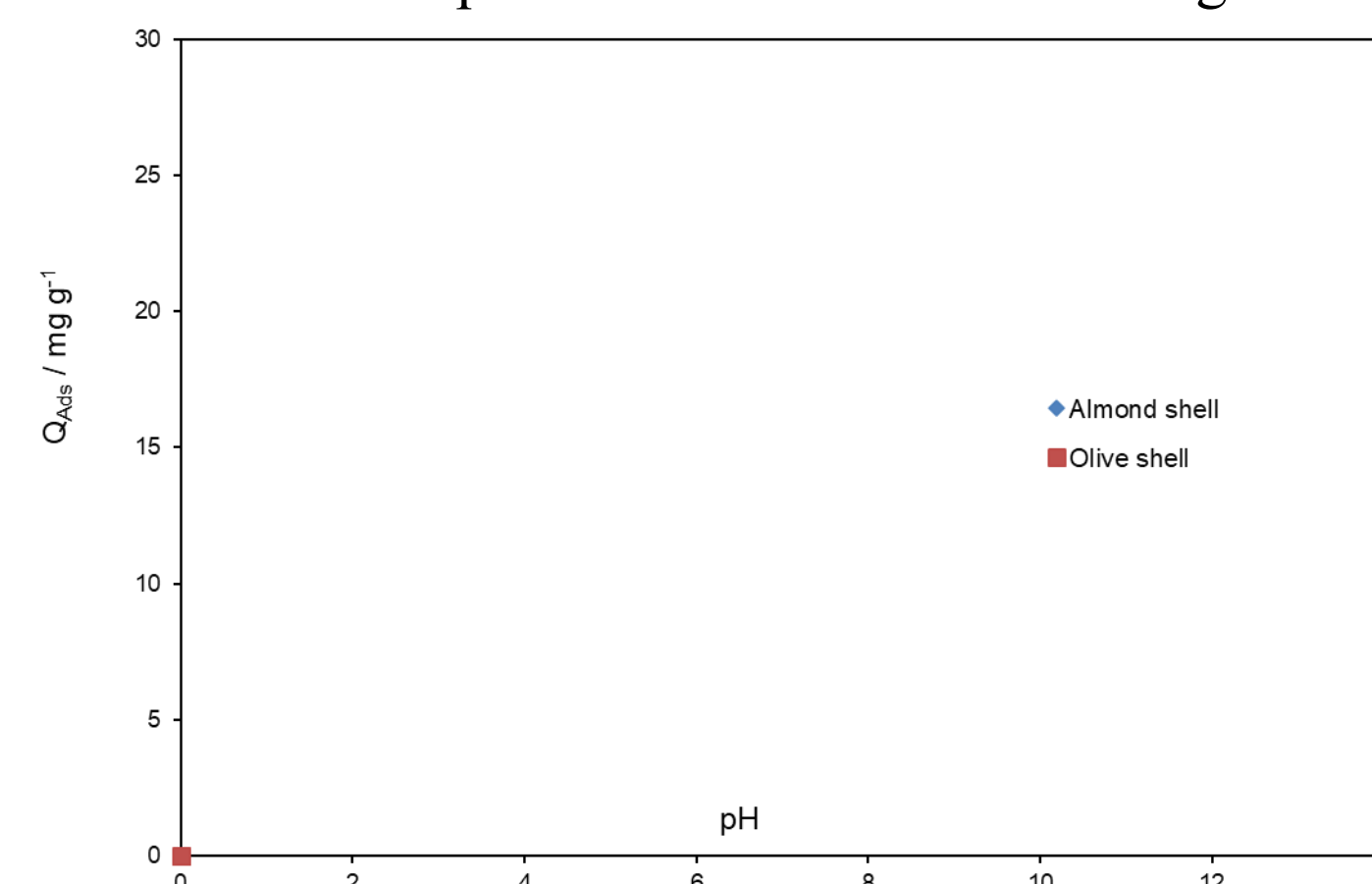


Figure 3- Influence of pH on MB removal by natural adsorbents

Natural adsorbents performed well in removing methylene blue dye from aqueous solutions. Among the agricultural residues evaluated, coconut husks stood out, presenting the highest removal capacity, reaching a maximum value of 106 mg g⁻¹, under conditions of 298 K, pH 6, and an equilibration time of 24 hours.

The influence of pH and temperature on adsorption efficiency was also studied. The results demonstrated that, in acidic environments, adsorption is significantly lower compared to values obtained in neutral and basic environments. It was also observed that temperature variations did not significantly alter the maximum adsorption capacity of the materials studied.

CONCLUSION

Natural adsorbents generally demonstrate good performance in removing MB from the liquid phase.

The use of residues from agricultural activities and the timber sector as adsorbents for removing dyes from aqueous media proves to be an effective solution, constituting a sustainable alternative to traditionally used materials, such as activated carbons.

This approach is in line with the principles of the circular economy, promoting the valorization of waste and reducing environmental impacts.

FUTURE WORK / REFERENCES

[1] Rendón-Castrillón, L., Ramírez-Carmona, M., Ocampo-López, C., González-López, F., Cuartas-Urbe, B., & Mendoza-Roca, J. A. (2023). Treatment of water from the textile industry contaminated with indigo dye: A hybrid approach combining bioremediation and nanofiltration for sustainable reuse. *Case Studies in Chemical and Environmental Engineering*, 8, 100498. <https://doi.org/10.1016/j.cscee.2023.100498>