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Study of the Removal of Organic Pollutants from Aqueous Solutions Using Organic Hydrogels and Biochars

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INTRODUCTION & AIM

Hydrogels are three-dimensional polymer networks that absorb large amounts of water and swell without dissolving, thanks to chemical crosslinks in their polymer network. These properties make hydrogels ideal for applications in controlled drug release, nanomaterial incorporation, and semiconductor technologies. Of particular importance is their ability to purify water, as they bind and retain various water-soluble pollutants.
Biocarbon, has a highly porous structure and large specific surface area, is equally effective in absorbing organic and inorganic pollutants from aqueous solutions, used in environmental protection applications such as heavy metal removal and soil quality improvement.
Parabens (e.g., Propyl Paraben) and the herbicide Metribuzin were studied as water pollutants. Parabens are widely used in food, pharmaceuticals, and cosmetics, while Metribuzin, a triazinone herbicide used to control weeds, is frequently detected in aquatic environments due to agricultural runoff.
In the present study, UV-Vis spectrometry and High Performance Liquid Chromatography (HPLC) techniques were used to evaluate the adsorption of the preservative Propyl Paraben and the herbicide Metribuzin (MEB) by negatively charged hydrogels P(DMAM-co-ANax) and biochars from lime peel. The stadart solutions had an initial concentration of 5 $mg \cdot L^{-1}$ and the adsorbents were used at a mass ratio of 0.1-0.5 g. The evaluation was performed at three concentrations (5 $mg \cdot L^{-1}$, 2.5 $mg \cdot L^{-1}$ and 1 $mg \cdot L^{-1}$), with the samples remaining for 4 hours in the adsorption state. The swelling ratio and adsorption capacity were evaluated.

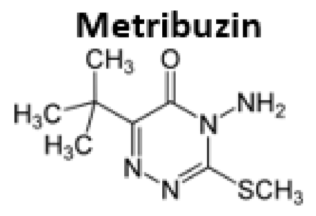
Keywords
Hydrogels, Biochars, Adsorption, Uv-Vis spectrophotometry, HPLC

METHOD

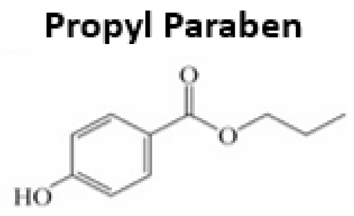
Standard solutions of the pollutants herbicide Metribuzin and Propyl Paraben were prepared in the concentration range of 0.5–5 $mg \cdot L^{-1}$. The corresponding pollutant solutions were mixed with the adsorbent materials as follows:
•0.1 g of hydrogels PDMAM-co-ANAx = 0.2, 0.5, and 0.7
•0.5 g of biochars derived from olive pit and lime peel.

Quantification of the pollutants was performed using Ultraviolet–Visible Spectrophotometry (UV–Vis) and High-Performance Liquid Chromatography (HPLC). The equilibrium time for both types of adsorbent materials was determined to be 4 hours.
The hydrogels were synthesized using N,N-Dimethylacrylamide (DMAM), Acrylic Acid (AA), N,N′-Methylenebisacrylamide (BIS), Tetramethylethylenediamine (TEMED), and Ammonium Persulfate (APS).
The biochars were produced by pyrolysis of the raw materials under controlled temperature 800°C for 3hr conditions, aiming to obtain materials with high porosity and enhanced adsorption capacity.

Metribuzin

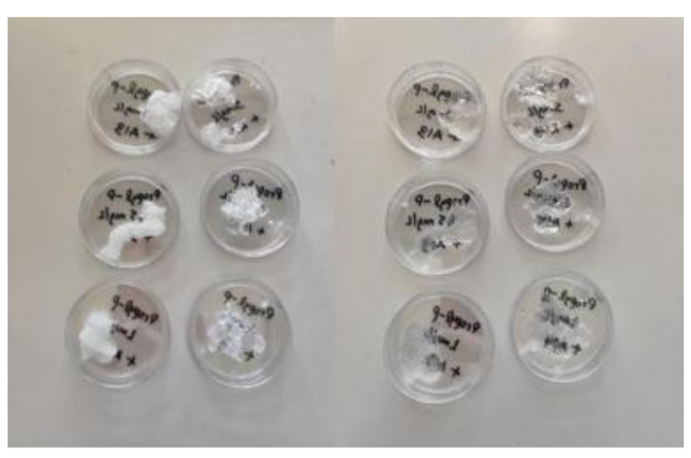


Propyl Paraben



Standard solution of herbicide Metribuzin

Standard solution Propyl Paraben



Hydrogels before and after adsorption

Biochar before and after pyrolysis

RESULTS & DISCUSSION

The results of adsorption herbicide metribuzin with the hydrogel P(DMAM-co-ANAx),x=0.5 are presented in the Figures below.

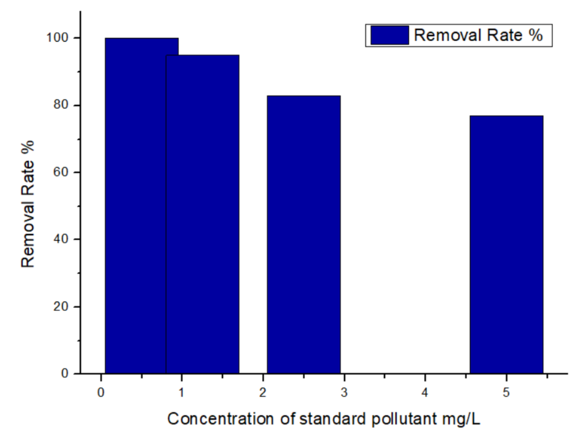


Figure 1. Relationship of removal efficiency (R%) as a function of the concentration of the pollutant Metribuzin (C_0, mg/L).

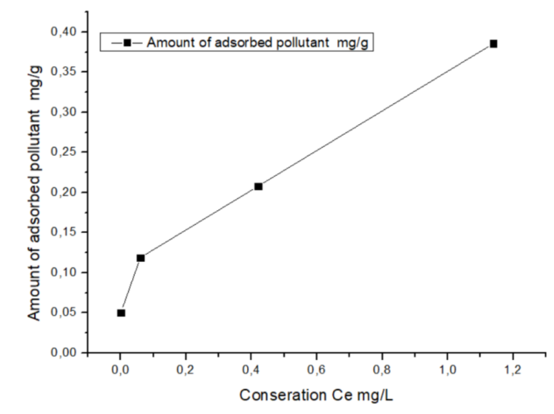


Figure 2. Amount of adsorbed pollutant *Metribuzin* (q_e, mg/g) as a function of the final concentration in the solution (C_e, mg/L).

The results of adsorption herbicide metribuzin with the hydrogel P(DMAM-co-ANax), x=0.7 are presented in the following Figures.

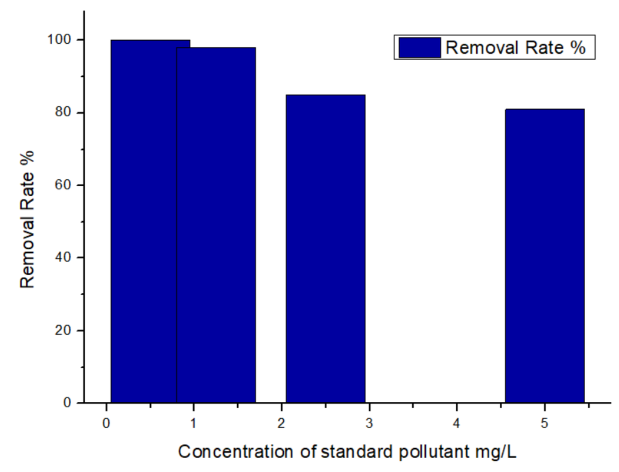


Figure 3. Relationship of removal efficiency (R%) as a function of the concentration of the pollutant Metribuzin (C_0, mg/L).

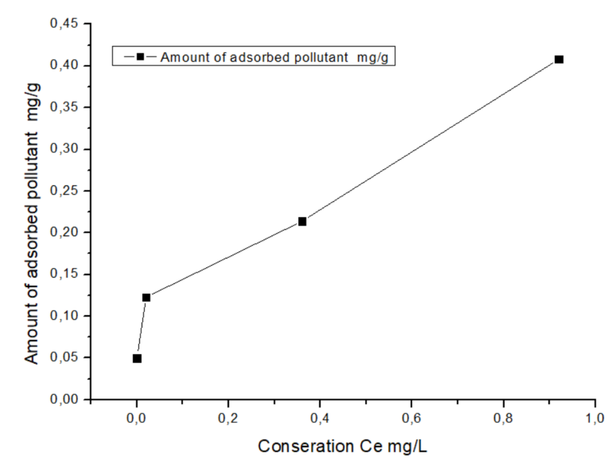


Figure 4. Amount of adsorbed pollutant *Metribuzin* (q_e, mg/g) as a function of the final concentration in the solution (C_e, mg/L).

The results of adsorption Propyl Paraben with the hydrogel P(DMAM-co-ANax), x=0.2 are presented in the Figures below.

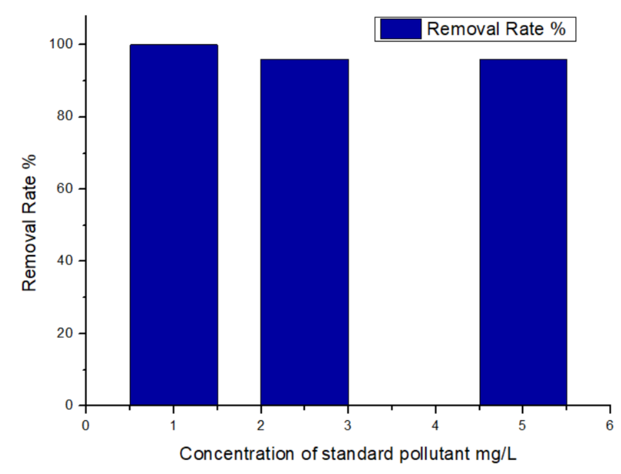


Figure 5. Relationship of removal efficiency (R%) as a function of the concentration of the pollutant Propyl Paraben (C_0, mg/L).

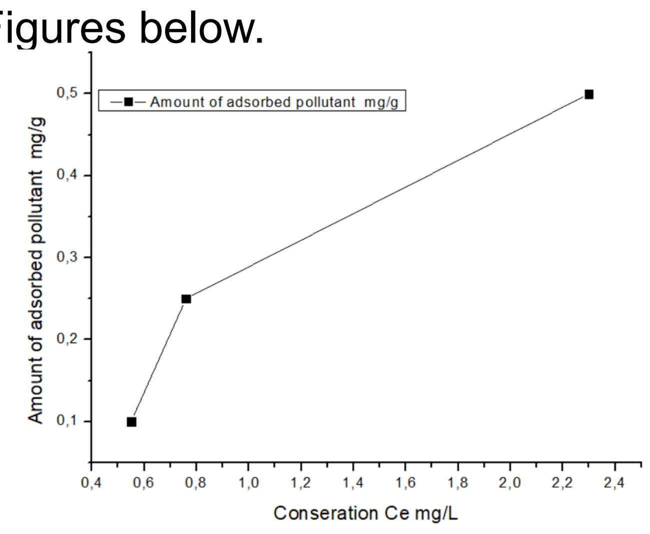


Figure 6. Amount of adsorbed pollutant *Popyl Paraben* (q_e, mg/g) as a function of the final concentration in the solution (C_e, mg/L).

The results of adsorption with Lime Peel Biochar are presented in the following Figures.

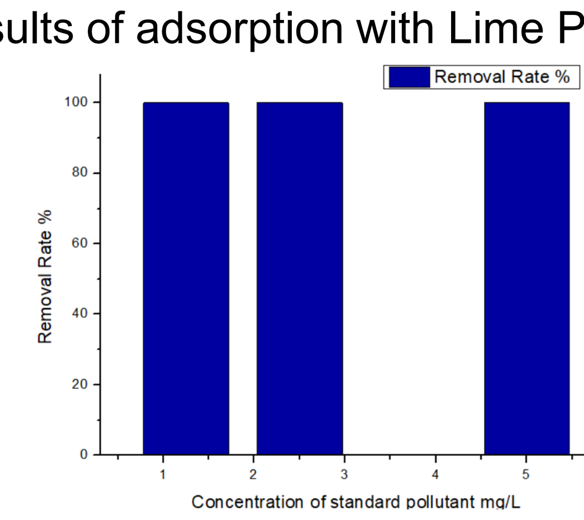


Figure 7. Relationship of removal efficiency (R%) as a function of the concentration of the pollutant Propyl Paraben (C_0, mg/L).

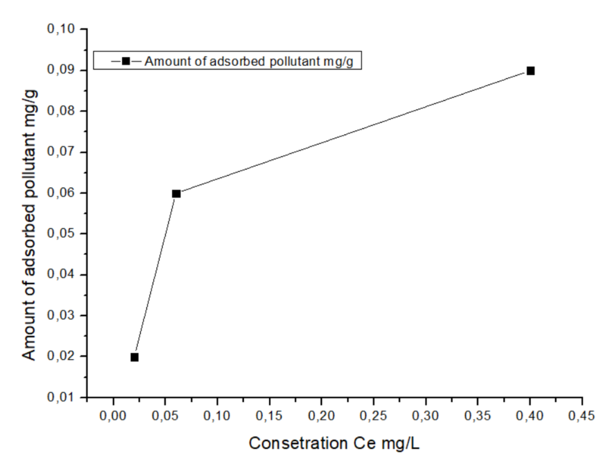


Figure 8. Amount of adsorbed pollutant *Propyl Paraben* (q_e, mg/g) as a function of the final concentration in the solution (C_e, mg/L).

The adsorption results (Ce/Qe) show that all P(DMAM-co-ANax) hydrogels exhibited high organic pollutant removal capacity. Lime Bark Biochar exhibited lower but stable adsorption capacity.

CONCLUSION

The spectrophotometric study of Metribuzin showed that its removal increases with concentration, reaching up to 95% for 5 $mg \cdot L^{-1}$. The hydrogel showed a high adsorption capacity, similar to P(DMAM-co-ANax), x=0.5, which achieved complete removal (100%). The results of the removal of the pollutant Propyl Paraben show that the removal efficiency (R%) is particularly high at 100% for all concentrations studied for the lime peel biochar. The organic hydrogel P(DMAM-co-ANax), x=0.2 achieves very high removal rates across the entire concentration range (96-100%).

FUTURE WORK / REFERENCES

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