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REMOVAL OF HEAVY METALS FROM DRINKING WATER THROUGH AGRI-FOOD BIOADSORBENTS

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INTRODUCTION & AIM

Heavy-metal pollution poses environmental and health risks: Cr^{6+} is a recognised human carcinogen and Al^{3+} is linked to potential neurotoxicity. Spanish RD 3/2023 sets 25-50 µg/L for total chromium and 200 µg /L for aluminum in drinking water.

Biosorption consists in using low-cost biomasses and it offers an effcient, affordable alternative to conventional treatments.

The principal aims were (1) to evaluate pig bristles (PB) and rice- husk reject (RH) as biosorbents for Cr^{6+} and Al^{3+} in synthetic waters; (2) to study the effects of pH, initial concentration of metal and acid pretreatment of PB; (3) to verify mechanisms by FT-IR; (4) to fit data to Langmuir/Freundlich isotherms.

METHOD

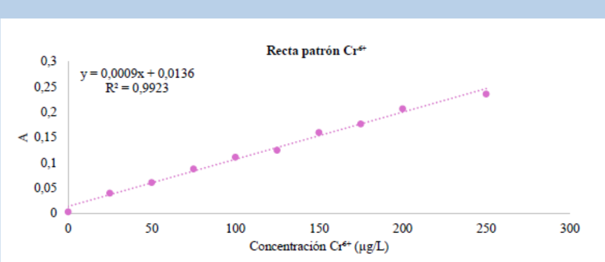
Biosorbents: pig bristles (MAGUISA, Guijuelo) cleaned, by 0.2 M NaOH (48 h), then acid hydrolysis HCl 8 M (16.5 h); rice-husk reject (ICMM-CSIC) used without pretreatment.

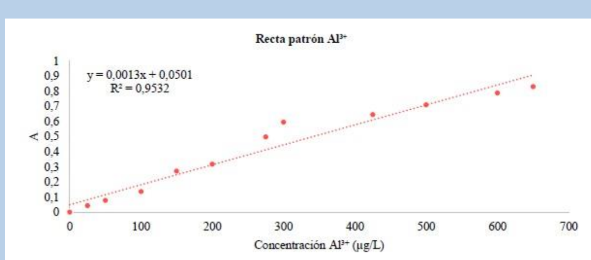
Analytics:

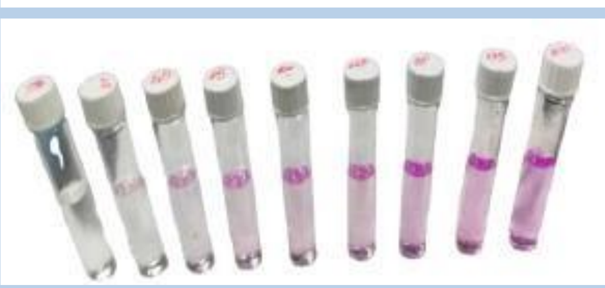
- Cr^{6+} by 1,5-diphenylcarbazide, 540 nm; calibration $R^2 = 0.9923$ (0–250 µg/L).
- Al^{3+} by eriochrome cyanine R, ≈535 nm; calibration $R^2 = 0.9532$ (0–650 µg/L).

Batch tests conditions: 10 mL, 0.10 g biosorbent, 150 rpm, 22 °C, 240 min; pH 3.0 (Cr^{6+}) and pH 4.0 (Al^{3+}); ranges: Cr^{6+} 20–200 µg/L, Al^{3+} 100–600 µg/L.

Modeling: Langmuir/Freundlich isotherms. FT-IR used to probe functional groups before/after metal uptake.







FUNDING

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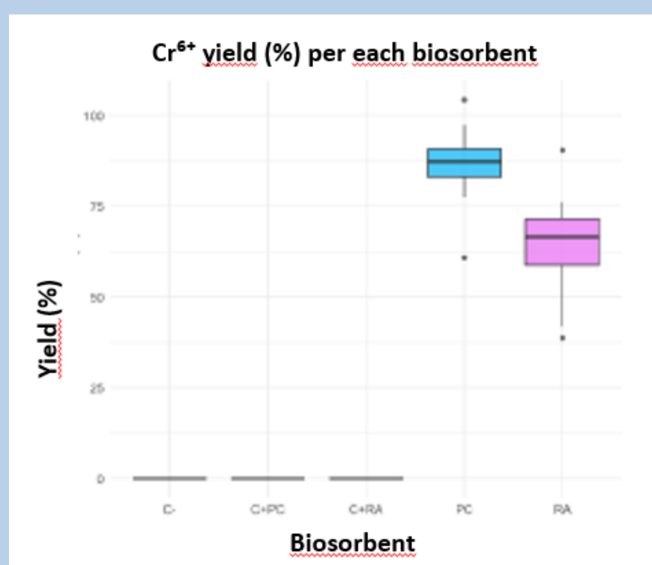
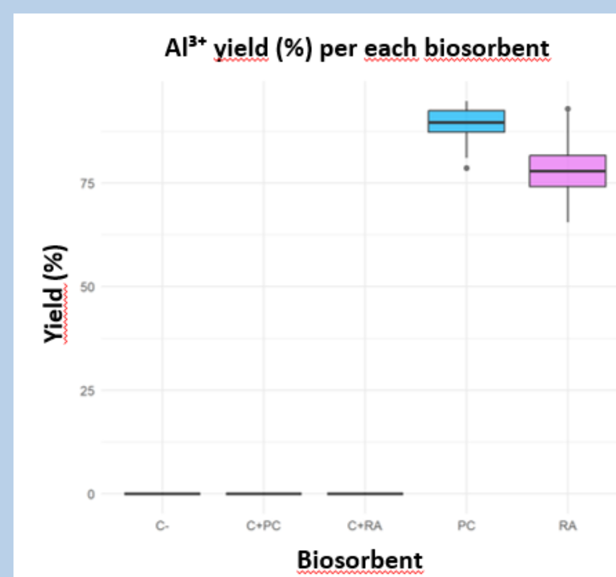
RESULTS & DISCUSSION

- Cr^{6+} removal (20–200 µg/L): Pig bristles (PB) consistently achieved ≥ 85 %, outperforming rice husk (RH) (~ 65 %). Data fitted Langmuir, suggesting monolayer adsorption on homogeneous sites.
- Al^{3+} removal (100–600 µg/L): PB reached ~ 84–92 % (peak ≈ 92.4 % at 400 µg/L); RH delivered ~ 71–91 % with higher variability; Langmuir again provided the best fit.
- Mechanism (FT-IR): spectra changes indicate participation of $–NH_2$, –COOH, –OH, –SH (keratin matrix) in metal binding; high Cr^{6+} exposure was used in FT-IR to ensure detectable band shifts.
- Interpretation: PB's superior performance is attributed to its keratin-rich surface with abundant functional groups; RH is effective but structurally more heterogeneous (siliceous fraction).





CONCLUSION

- Acid-treated pig bristles show high capacity and efficiency for Cr^{6+} and Al^{3+}, surpassing rice husk under the tested conditions. Equilibrium follows Langmuir, and kinetics are compatible with pseudo-first-order behavior. FT-IR supports the role of keratin functional groups in metal uptake. This is a low-cost, circular-economy approach for water remediation.

FUTURE WORK / REFERENCES

- Validation in real waters (interferents, multi-metal competition); textural (BET) and surface (SEM-EDX/XPS) characterization; regeneration/reuse and fixed-bed trials; techno-economic and LCA assessment.