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Method development for on-site freshwater analysis with pre-concentration of nickel via ion-exchange resins embedded in a cafetière system and paper-based analytical devices for readout

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Heavy-metal analysis of water samples using microfluidics paper-based analytical devices (µPAD) with colourimetric readout is of great interest due to its simplicity, affordability and potential for Citizen Science-based data collection [1]. However, this approach is limited by the relatively poor sensitivity of the colourimetric substrates, typically achieving detection within the mg L^{-1} range, whereas heavy-metals exist in the environment at <µg L^{-1} quantities [2]. Preconcentration is commonly used when analyte concentration is below the analytical range, but this typically requires laboratory equipment and expert users [3]. Here, we are developing a simple method for pre-concentration of heavy metals, to be integrated with a µPAD workflow that would allow Citizen Scientists to carry out pre-concentration as well as readout on-site.

The filter mesh from an off-the-shelf cafetière (350 mL) was replaced with a custom-made bead carrier basket, laser cut in PMMA sheet featuring >500 evenly spread 100 µm diameter holes. This allowed the water sample to pass through the basket and mix efficiently with the 2.6 g ion-exchange resin beads housed within (Lewatit® TP207, Ambersep® M4195, Lewatit® MonoPlus SP 112). An aqueous Ni^{2+} sample (0.3 mg L^{-1}, 300 mL) was placed in the cafetiere and the basket containing ion exchange material was moved up and down for 5 min to allow Ni^{2+} adsorption onto the resin. Initial investigations into elution with a safe, non-toxic eluent focused on using NaCl (5 M). These were carried out by placing the elution solution into a shallow dish and into which the the resin containing carrier basket was submerging. UV/vis spectroscopy via a colourimetric reaction with nioxime was used to monitor Ni^{2+} absorption and elution.

After 5 min of mixing it was found that Lewatit® TP207 and Ambersep® M4195 resins adsorbed up to 90% of the Ni^{2+} ions present in solution and the Lewatit® MonoPlus SP 112 adsorbed up to 60%. However, the Lewatit® MonoPlus SP 112 resin performed better for elution with NaCl. Initial studies showed up to 30% of the Ni^{2+} was eluted within only 1 min of mixing with 10 mL 5 M NaCl.

Using a cafetière as pre-concentration vessel coupled with non-hazardous reagents in the pre-

concentration process allows involvement of citizen scientists in more advanced environmental monitoring activities that cannot be achieved with a simple paper-based sensor alone. Future work will investigate the user-friendliness of the design by trialling the system with volunteers and will aim to further improve the trapping and elution efficiencies.

References:

- Almeida, M., et al., Talanta, 2018, **177,** 176-190.
- Lace, A., J. Cleary, Chemosens., 2021. **9**, 60.
- Alahmad, W., et al.. Biosens. Bioelectron., 2021. **194,** 113574.