Carbohydrate polymers could be a sweet solution for water purification

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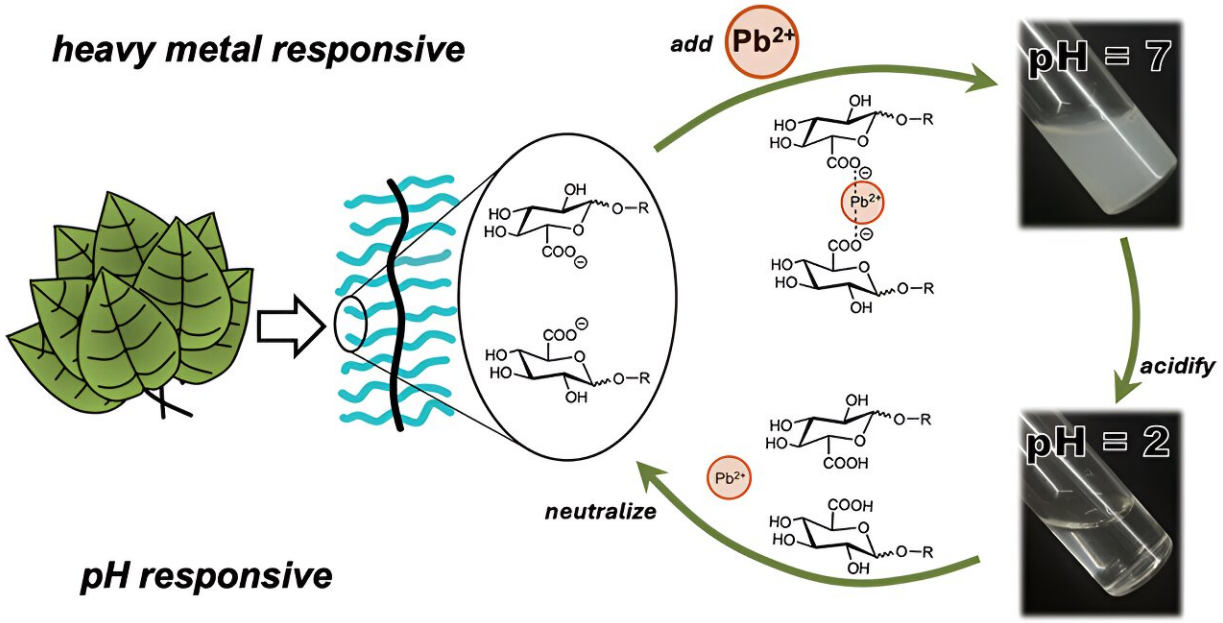

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Water polluted with heavy metals can pose a threat when consumed by humans and aquatic life. Sugar-derived polymers from plants remove these metals but often require other substances to adjust their stability or solubility in water.

Now, researchers report a sugar-like polymer that traps heavy metals

within insoluble clumps for easy removal. In proof-of-concept tests, the polymer removed ionic cadmium and lead from river water spiked with these persistent contaminants. The work has been published in *ACS Central Science*.

Some heavy metal ions can be toxic at high levels in drinking water. Methods for removing these contaminants, such as filtration, can be energy intensive and rely on metal-capturing membranes that clog quickly and must be replaced. To improve water purification, researchers have turned to plants.

Plants defend their cells with a barrier of polysaccharides, made of macromolecules with repeating sugar units, that trap metal ions. For example, in a recent study, researchers used sticky polysaccharide extracts from okra and aloe to remove microplastics from wastewater.

However, some polysaccharides dissolve in water, requiring additives to form insoluble gels for metal capture and removal. So, Cassandra Callmann and her research team at the University of Texas at Austin set out to design a single material with sugar-like structures and controllable water solubility to remove heavy metals from water.

The team constructed several polymers, each having a water-insoluble backbone with different water-soluble carbohydrates dangling from the repeating units like charms on a bracelet. In initial tests, the carbohydrate "charm" that attracted and bound ionic cadmium most efficiently contained a carboxylic acid group.

Next, in tests of water spiked with ionic cadmium, the polymer with carboxylic acid formed visible clumps after three minutes, and the clumps could be filtered out. The clumps also redissolved, releasing the cadmium, by adjusting the acidity of the water. After three cycles of binding, clumping and redissolving, the polymer maintained the same

metal-trapping efficiency, demonstrating its potential as a recyclable material.

As a proof-of-concept, the team next tested the carbohydrate-containing polymer on Colorado River water spiked with ionic cadmium and lead. The river sample contained substantially more ionic calcium, sodium and magnesium than the added metals.

Over a 24-hour period, the polymer captured up to 20% and 45% of the added cadmium and lead, respectively, and minimal amounts of the other metal ions. The researchers say their new material is a promising step towards more efficient, reusable and selective materials for water purification.

More information: Bioinspired, Carbohydrate-Containing Polymers Efficiently and Reversibly Sequester Heavy Metals, *ACS Central Science* (2024). DOI: 10.1021/acscentsci.4c01010. pubs.acs.org/doi/full/10.1021/acscentsci.4c01010

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