Mimicking Molecules Made by Bacteria to Remove Metals From Water

NIEHS Superfund Research Program (SRP)-funded scietists developed a method to extract metals from water using synthetic molecules inspired by those produced by bacteria. The biodegradable molecules, called rhamnolipids, could one day be used to remove toxic metals or extract rare and valuable elements from water.

Growing desire for battery-powered devices, like electric vehicles, will likely raise demand for rare earth elements and metals. Traditional mining for rare earth elements and other metals disturbs natural resources and contributes to greenhouse gas emissions. Obtaining some rare metals from liquid waste – from oil and gas production or acid mine drainage – could potentially meet demand and reduce environmental impacts.However,selective, cost-effective approaches to extract metals from water are not currently available.

Researchers at the University of Arizona SRP Center studied seven different synthetic rhamnolipids to evaluate their ability to remove metals from solutions by forming a solid complex.

The synthetic rhamnolipids were tailored to vary in their properties based on differences in tail length, from six to 18 carbons, and to have one or two tails. Longer tails and multiple tails impart greater hydrophobic, or water-repellant, properties.

The scientists tested the ability of the rhamnolipids to form a complex with each metal – lead, lanthanum, or magnesium – at different concentrations. Then they compared three treatments to remove the rhamnolipid-metal complexes from solution: mixing only or mixing followed by an active removal step of either filtering or centrifuging, which condenses solids through rapid spinning.

Depending on the rhamnolipid structure, the metal, the ratio of rhamnolipid to metal, and the removal step used, the team observed differences in how the molecules formed complexes with the metals and how efficiently metals were removed.

Overall, rhamnolipids with greater hydrophobicity were more effective at forming complexes with the metals, performing best with lead, followed by lanthanum, and magnesium. Adding the filter or centrifuge step generally improved performance with the same general trend by metal type.

Under the right conditions, rhamnolipids were able to remove more than 97% of lead or lanthanum, and up to 93% of magnesium.

According to the team, these results suggest that tailoring rhamnolipid structure and removal methods may enable selective and environmentally-friendly extraction of either toxic metals or valuable rare earth elements. The efficiency of these techniques in more complex systems, such as metal mixtures or in more realistic waste streams, should be evaluated in future studies, they added.

If you'd like to learn more about this research, visit the Superfund Research Program website at niehs.nih.gov/srp. From there, click on the Research Brief title under the banner, and refer to the additional information listed under the research brief. If you have any questions or comments about this month's podcast, send an email to srpinfo@niehs.nih.gov.

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