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Filtering Poisons With Seeds

Waste from vegetable oil manufacturing could cheaply and effectively remove toxic heavy metals from contaminated water, find a Singaporean-Swiss research team

Asian Scientist Magazine (Aug. 3, 2022) — When you next reach for cooking oil, you might consider how the plants it came from could also help clean your drinking water. Using leftovers from sunflower and peanut oil manufacturing, a team of Singaporean and Swiss researchers have created a membrane that can effectively filter heavy metal ions from contaminated water, purifying it to international safety standards in a simple, cheap, gravity-based process needing little to no electricity.

> "[This process] allows us to reprocess waste streams for further applications and to fully exploit different industrial food wastes into beneficial technologies," said Soon Wei Long, lead author who is a PhD student at Nanyang Technological University (NTU), Singapore.

The study was published in *Chemical Engineering Journal* and co-led by Professor Ali Miserez from NTU with Professor Raffaele Mezzenga from the Swiss Federal Institute of Technology in Zurich (ETHZ), Switzerland.

When oily seed crops or oilseeds are processed into edible oils, what remains is oilseed meal; a protein-rich by-product often thrown away or fed to animals. However, the team found that proteins extracted from oilseed meal could be shaped into amyloid fibrils, which are nanometre-sized ropes of tightly-wound protein molecules.

Amyloid fibrils have an unusually strong ability to adsorb—that is, to attract and trap—heavy metals and radioactive substances, thanks to amino acid bonds that sandwich such particles while letting water through, Miserez explained.

> "Heavy metals represent a large group of water pollutants that can accumulate in the human body, causing cancer and mutagenic diseases," said Miserez. "Current technologies to remove them are energy-intensive, requiring power to operate, or are highly selective in what they filter."

In 2016, a previous study by Mezzenga found fibrils made with cow milk whey could remove such substances from contaminated water with over 99% efficiency, acting like a molecular sieve. What's more, they could do this passively, with no electricity needed for the filtration process.

However, while a passive whey-based filter might seem more sustainable versus active electrical processes like reverse osmosis, it can also be costly to scale up, since whey is also a source of human food.

The NTU-ETHZ team built on Mezzenga's findings and those of other studies that showed plant proteins from soybean and maize—even in non-fibril form—could adsorb heavy metals. They honed in on oilseed meals as a potential low-cost material available in large amounts. Over 25 million tonnes of sunflower and peanut oils were produced in the 2020–2021 growing year alone, worldwide.

To amplify the fibrils' adsorptive effects, the team wove them together with activated carbon—another common filtration material—to form a hybrid membrane. When tested on simulated wastewater contaminated by chromium, platinum, and lead, the membrane filtered up to 99.89% of the pollutants contained.

The team found around 160 g of usable protein could be extracted from a kilo of oilseed meals. To filter an Olympic-sized swimming pool of water contaminated with 400 parts per billion (ppb) of lead—40 times the safety threshold for drinking water set by the World Health Organization—would take just 16 kg of sunflower seed protein, they estimated.

Once extracted, the heavy metals could be disposed of or even recovered by burning the membranes; especially platinum, which is vital in electronics manufacturing.

> "Our protein-based membranes are created through a green and sustainable process, and require little to no power to run, making them viable for use throughout the world and especially in less developed countries," said Miserez. "Our work puts heavy metal where it belongs—as a music genre and not a pollutant in drinking water."

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Source: Nanyang Technological University; Photo: Shutterstock

The article can be found at: Soon et al. (2022) Plant-based amyloids from food waste for removal of heavy metals from contaminated water.

#contaminated water #cooking oil #filtration #Nanyang Technological University #oil meal

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