Sensor detects toxins in drinking water sources

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A satellite image of algal blooms on Lake Erie. Credit: NASA

University of Cincinnati researchers have developed a sensor that detects toxins from algal blooms that taint surface water such as rivers, lakes and streams. Early detection of these toxins can aid water treatment plants to adjust the treatment strategy to keep the dangerous substances from contaminating drinking water.

The research is led by Dionysios Dionysiou, professor of environmental engineering, with his student, Vasileia Vogiazi, who recently earned her doctoral degree from UC in environmental engineering.

The researchers created an electrochemical aptamer-based sensor that detects and measures microcystin cyanotoxin in water. Microcystins are the toxic byproducts of harmful algal blooms, which develop when fertilizer used in agriculture leaches into bodies of water. Exposure through drinking water may cause liver damage, tumor growth and gastroenteritis.

Once the cyanotoxins are detected in the finished drinking water it's more challenging to remove—which occurred in Toledo, Ohio, in 2014 and led to a do-not-drink order for 500,000 consumers. Early detection with the sensor in the freshwater source, such as Lake Erie in the Toledo case, would alert water treatment plants to the presence of the toxins before the water enters the treatment facility.

"Conventional treatment processes are not always efficient in removing cyanotoxins. Contaminated water with these toxins is harder to treat," Vogiazi said. "If the toxins pass several treatment stages, an unfortunate increase in the cost and major difficulties in the general management of a treatment plant is expected."

Funded by a grant from the National Science Foundation, the findings were published in the journal *ACS ES&T Engineering*.

Project collaborators included researchers from across several disciplines at UC: Vesselin Shanov, professor of chemical engineering; Ryan White, associate professor of electrical engineering and chemistry; and Bill Heineman, distinguished research professor of chemistry. Researchers from the Environmental Protection Agency—Armah de la Cruz and Eunice Varughese—also contributed.

"Vasileia was very motivated. She went over the typical environmental engineering kind of training," Dionysiou said. "She went to the chemistry department to learn aspects related to the electrochemistry and sensor development, she did some testing with a company that makes aptamers, and she had amazing support with sensors from Professor Bill Heineman and Professor Ryan White."

Using water samples taken from Lake Erie and other Ohio bodies of water, the researchers employed their sensor to successfully detect and measure the amount of a specific type of microcystin commonly found in the region. The next step for future research is to expand the types of toxins the sensor can detect and create a prototype device to be used in the field.

"We focused on microcystins which are very commonly found here in Ohio and other places, but there are other important toxins, so we want to develop modified sensors that can be selective for other toxins, as well as sensing devices that can detect and quantitatively measure multiple cyanotoxins in water," Dionysiou said.

More information: Vasileia Vogiazi et al, Sensitive Electrochemical Detection of Microcystin-LR in Water Samples Via Target-Induced Displacement of Aptamer Associated [Ru(NH3)6]3+, *ACS ES&T Engineering* (2021). DOI: 10.1021/acsestengg.1c00256

Provided by University of Cincinnati

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